EVERY BOY'S BOOK OF RAILWAYS & STEAMSHIPS

ERNEST PROTHEROE F.Z.S.

FULLY ILLUSTRATED

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OF

RAILWAYS AND STEAMSHIPS

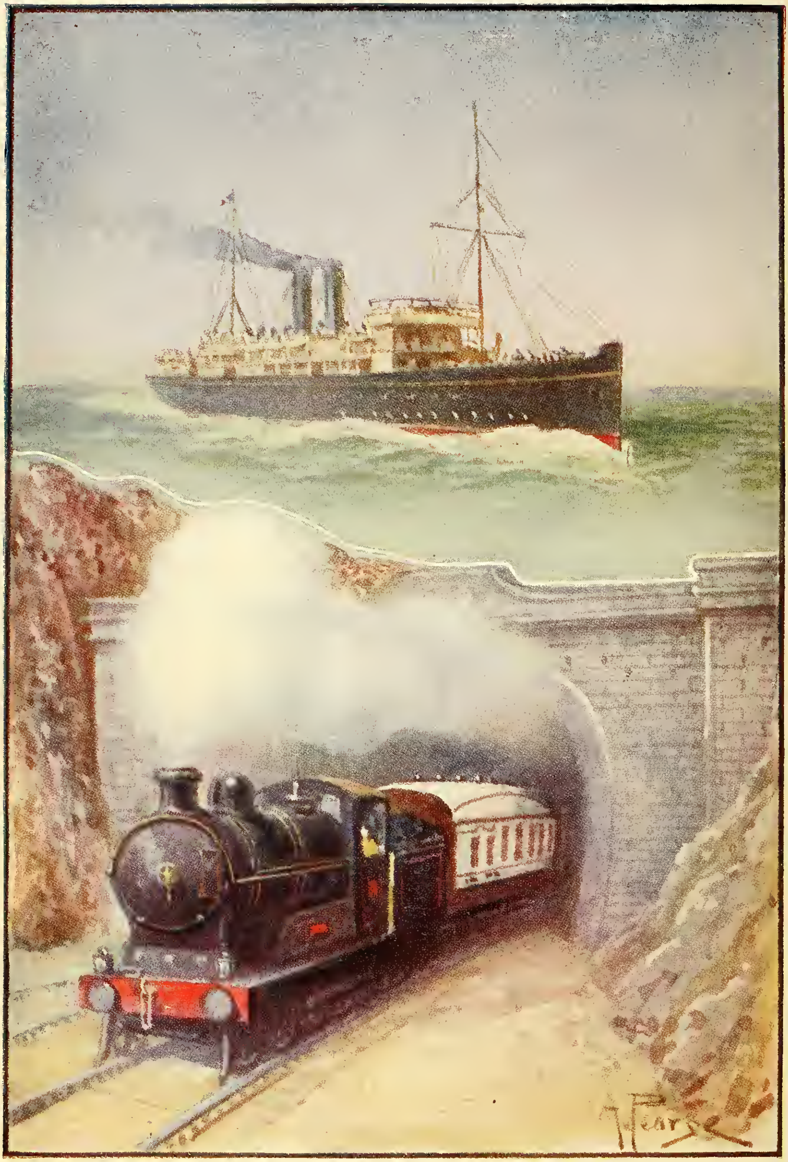

PLATE A.

THE TRIUMPHS OF STEAM.

EVERY BOY'S BOOK

OF

RAILWAYS AND STEAMSHIPS

BY

ERNEST PROTHEROE
AUTHOR OF "THE HANDY NATURAL HISTORY," ETC., ETC.

WITH COLOURED PLATES AND NUMEROUS OTHER ILLUSTRATIONS

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PREFACE

NOTHING perhaps appeals more to the imagination of the tiny toddler, or stirs up more undiluted joy than a train or a ship; and models of either are always prime favourites among hosts of popular toys. Childish interest in mere toys weakens and at last disappears with the passing years; but in the case of trains and ships it is but transferred from the models to the actualities. It is quickly borne in upon even the young mind, that locomotives and steamships touch life at many vital points; they have become necessary adjuncts to our comfort and, in some respects, to our very existence.

In the following pages is a brief account of the triumphs of steam as applied to traction on land and propulsion through water. No attempt has been made to give long lists of either engines or ships; and technical and difficult terms have been avoided wherever possible. The main idea of the volume is to describe the victories of the locomotive and the marine engineer, to show how they have assisted to build up our national greatness, while at the same time they have spread civilisation, and helped to swell the everlasting Kingdom "that ruleth over all."

Much of the information has been supplied at first-hand by the various railway and shipping companies mentioned, together with many of the illustrations; and thanks are tendered to all who have rendered aid in these directions.

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GREAT WESTERN RAILWAY, No. 4021 "KING EDWARD," 4-6-0, 4-CYLINDER LOCOMOTIVE, AS IT APPEARED WHEN IT DREW THE ROYAL FUNERAL TRAIN, MAY 20TH, 1910.

CHAPTER I

THE ADVENT OF A GIANT

THE rapid rise and progress of the British nation is an oft-told story. The Romans taught us the first elements of civilisation, notably road-making, and building in brick and stone. Alfred the Great laid the foundation of our navy. The Norman Conquest introduced us to numerous comforts and refinements of continental life, and in the year 1190 Richard the Lion-Heart set out with a fleet for the Holy Land, a feat which showed the enormous progress that Britain had made during the passage of but a few centuries. In the fifteenth century came the invention of the printing press, that marked the dawn of one of the greatest eras, not only in our own but in the history of the world.

Thanks to her soldiers, sailors, and restless adventurers, England made amazing progress; but it was the discovery of coal, followed by the invention of all kinds of machinery, that set the seal upon her greatness. She became the world's manufacturer in iron, cotton, woollen and various useful productions. Her commodities were eagerly demanded in foreign markets, and trade brought to our country greater wealth than military or naval victories alone could ever have achieved.

Let us look back only a century and a half. Clive in India, and Wolfe in Canada, had just proved the superiority of our arms over the French, although the question was not really settled until the final defeat of Napoleon at Waterloo in 1815. Our ships, in never-ceasing procession, brought to Britain's shores raw products for our factories to mould and weave and fashion into articles that mankind was finding to be daily necessities.

Spinning and weaving are two of the oldest industries; from almost the infancy of the world man was a weaver of woollen cloths; the Chinese silk industry dates back at least five thousand years; and cotton spinning was known in India and China many centuries before it was introduced into Europe. After the fall of Antwerp in 1585, a number of silk weavers took refuge in England and gave rise to an important industry. In England cotton was first spun by machinery in 1740, which before the end of the century was improved by the famous inventions of Hargreaves, Arkwright, Crompton, and others. The improved machinery marked another great advance in industrial progress, but the new machines were at first worked by horses or, at best, by water.

At this time an anxious world was awaiting the advent of a new giant, or rather one who had been slumbering since the beginning of time. Clever brains were puzzling how to find the means of waking him up, so that he could be utilised in the service of man. Many times he had been roused into partial consciousness, but again and again he contrived to slip out of the harness that was prepared for him. Eventually he was prodded into wakefulness, and from that moment he has never been allowed to sleep again. The giant's name is Steam.

Steam made the wheels of machinery go round faster than had ever been imagined was possible. Speed means cheapness, and thus has been brought within the reach of even the poor, a thousand and one benefits that otherwise would have been confined to the rich.

Manufactures, trade, and commerce always bring wealth to the peoples who engage in them, but only if they can be conducted with speed. Time is money, and it is money that greases the world's commercial wheels. Quickness of production and facility of transit are absolutely essential to cheapness, and cheapness is the key to the biggest markets.

It is to this question of transit that the following pages are devoted—a question full of interest and of paramount importance to the progress, comfort, and well-being of mankind.

In all ages, all over the world, the modes of travelling or of conveying goods for any considerable distance were the same, the carriers were either men or animals; and thus transit called for good roads. In Europe and Asia the horse was domesticated from very early times for war, for riding, and for use as a pack animal. Journeys on foot were not only tedious, but not infrequently downright dangerous; and for the conveyance of goods, in many cases, absolutely impossible.

Chariots were used in war by very ancient peoples. Frequently they were utilised for other purposes, as when Pharaoh made Joseph ride "in the second chariot which he had;" and when the monarch instructed Joseph's brethren: "Take you waggons out of the land of Egypt for your little ones and for your wives, and bring your father and come." A journey from Shechem to Goshen meant a tremendous undertaking—two hundred and fifty miles over a roadless, rough, and, more or less, sterile country in vehicles that would blush in the presence of a modern bricklayer's handcart.

In our country the ancient Britons had chariots, and the Saxons used rude solid-wheeled vehicles. In the time of Richard II. there was a wheeled carriage, called the "whirlcot." Hackney carriages first made their appearance in London about the year 1625, and the earliest stage-coach in the closing days of the Commonwealth.

For horse traction good roads are a prime necessity, and what our own roads were in the eighteenth century may be gauged from the fact that, when rain or snow made the road soft, a journey from Kensington to St. James's Palace occupied a couple of hours for the three miles; and in much more recent times a coach ordinarily took two days and three nights in travelling from Manchester to Glasgow.

Pack horses could travel in regions where wheeled vehicles were impossible, but a pack horse can carry little more than a hundredweight on its back, whereas it can draw thirty hundredweights on a good road per working day, in addition to the cart.

Our progress in manufactures led to the construction of good roads all over the kingdom, that the raw materials might be brought from the coast, and manufactured goods despatched to the ports, as well as for our internal general trade. Consequently, there set in an era of road building, and Telford and Macadam, in particular, worked wonders in that direction; in Scotland alone new roads called for the building of a thousand bridges; and the highway from Shrewsbury to Holyhead is only one of many excellent examples of road engineering of that period.

European roads are for the most part well graded and carefully constructed. Napoleon made roads even over the Alps to facilitate the progress of his armies, but they remain to this day, and render good service in the promotion of trade and commerce. But everywhere there are roads and roads. In Ecuador, in South America, it is 320 miles from Quito, the capital, to the coast. Until quite recent years goods were often two months on the road, and upon one occasion a postman was drowned in the mud. In some parts of the world, notably South Africa and some parts of America, oxen are employed to draw the heavy lumbering transit waggons over the rock-strewn apologies for roads; in desert regions only the camel can face the waterless journeys; the passes of the Andes and the Himalaya are traversed by the llama and yak respectively; and in the tropical regions of Africa goods can only be transported on the heads of native porters, each man carrying a burden of from forty to sixty pounds.

Nevertheless, in England, good roads, improved wheeled vehicles, and capital breeds of horses could not meet the increasing demand for speedy transit. But the giant Steam had worked a revolution as a motive power for machinery; and now it was sought to enlist his services in the propelling of wheeled vehicles, which for anything like a long distance could not accomplish more than ten to twelve miles an hour.

Steam has proved to be not only a giant, but a fairy. He has quickened and beautified life in innumerable ways. Almost haphazard we may note various appliances that are not merely the result of slow growth and improvement upon improvement, but really new departures, most of which the cleverest men only a century ago never even dreamt. Railways, steamships, bicycles, motor-cars, sewing-machines, typewriters, printing presses, machine reapers, the telegraph, electricity, Rontgen rays, and a whole host of modern inventions have imported vital energy into human affairs; contributed to our comforts and enjoyments in a thousand ways; and brought us nearer to the time when there shall be "no complaining in our streets."

It may be urged that steam is not responsible for many of the inventions just enumerated. The sewing machine is worked by the busy housewife, and the typewriter by the nimble fingers of the typist; but, all the same, it is steam and steam machinery that permits of the construction of practically all inventions at a price which brings them within the reach of all.

Without exaggeration it may be said, that the discovery of fire and its application to water are at the bottom of all the material discoveries that have made for the physical, and a great deal of the moral, betterment of mankind. It may be that we are yet only on the fringe of our world-heritage ; every passing year sees some fresh vista of understanding opened up to us. Not until the flame of knowledge lights up the whole world will man have come into the fulness of his earthly kingdom ; and we must so direct it that this same great flame shall light us on our way to the Kingdom of Heaven.

CHAPTER II

THE ROMANCE OF THE STEAM-ENGINE

BEFORE proceeding with the main object of this volume we must familiarize ourselves with at least the first principles of the steam engine; for whatever particular work different engines are meant to perform, there are certain salient features common to all of them.

The Ancients had more than a dim idea of the properties of heat and steam, and Hero of Alexandria in 150 B.C. certainly attempted to apply heat in the production of motion. He was more or less successful in various crude ways, *e.g.* by means of heated air, applied to jets of water, he opened and closed the doors of an Egyptian temple; and several machines of Hero's period produced blasts of vapour from heated water.

Anthemius, an architect, displayed both knowledge and ingenuity in venting his spite upon Zeno, his next-door neighbour. In his own house he placed cauldrons of water from which he passed tubes into the beams of Zeno's sitting-room. When the cauldrons were heated, the steam rushed up the pipes, and shook Zeno's apartment to such an extent that he thought in some way or other he had unwittingly offended the gods.

Captain Blasco de Garay, in 1543, exhibited in Barcelona harbour a steamboat moved by paddle wheels, which were driven by what purported to be a steam-engine, for "a vessel of boiling water" formed part of the apparatus. If this account be true, de Garay was the first to make steam useful in the development of real power; but too little is known of the invention to express any definite opinion.

Nearly a hundred years later an Italian engineer experimented with a steam wind-mill, the steam from a boiler being directed out of a spout against the flat vanes of a wheel, which was thus set in motion.

Nathaniel Nye, an English mathematician, invented a cannon that would throw a shot by the use of water instead of gunpowder. Upon the water he rammed a thick wooden air-tight wad upon which he placed the shot; and when fire was applied to the breach the water was converted into steam "till it burst suddenly." Nye's ingenious notion probably burst at the same time, for we learn nothing further of his invention.

The Marquis of Worcester, in his *Century of*

Inventions, describes a steam apparatus that enabled him to raise a column of water to a height of forty feet. This "Fire-waterwork" was performing useful work at Vauxhall in 1656; and thus the Englishman may reasonably claim to be the first man to evolve a really practical "fire-engine."

Sufficient has been said to illustrate the very important truth that "great inventions are never, and great discoveries are seldom, the work of any one mind." Often the final form of an invention is utterly unlike the original idea in which the apparatus had its birth.

The Marquis of Worcester and his contemporaries, as well as many who had gone before them, directed their energies to perfecting a steam pump. Dr. Papin, a clever Frenchman resident in London, in 1690 produced an engine in which a cylinder and piston were used for the first time. Eight years later, Captain Savery exhibited to the members of the Royal Society a working model of an engine, which he claimed would raise water, provide motion for all kinds of mill works, drain mines, serve towns with water, etc. The engine, of which so much was expected, was called the *Miner's Friend*; but it failed to drain the mines, because without safety-valves it was impossible to work the apparatus at the requisite pressure to force water to a height greater than a hundred feet. The most that could be claimed for the engine was that it drained ponds and swamps with fair success.

In the meantime two other men, Thomas Newcomen and John Cawley, were working together with promising results; and finally Savery joined them, because he held the patent which covered the greater part of the "fire-engines" upon which they were engaged. In 1705, a new patent was taken out for an "atmospheric" engine that was largely used in mine drainage during the next seventy years.

The men, who have been mentioned, were only the outstanding figures in a small army of inventors, who were keenly alive to the advantages of steam as a source of power over wind and water. Steam is not dependent upon the weather, its motion is constant and uniform, and it can be increased almost indefinitely within the limits of safety. The power was known to exist—it only remained to learn how to utilize it to the best advantage. The cylinder and piston had worked wonders, but quite three-fourths of the steam admitted to the cylinder were wasted. The yet crude engine was awaiting the man who should overcome this obstacle, and change the engine from a clumsy, wasteful contrivance into one that would create a new era in the arts, revolutionize industry, and influence civilization to a degree almost beyond computation.

This great honour was reserved for James Watt, who, in the first week of 1769, took out a patent for performing condensation in a vessel separate from the cylinder. The inventor was poor; his models were roughly constructed; his health broke down under the strain and anxiety; rivals attempted to appropriate his ideas; until he once confessed in a letter to a friend that "in life there is nothing more foolish than inventing." Upon his thirty-fifth birthday, he declared that he had "hardly done thirty-five pence worth of good in the world;" but the inventor's long lane of heart-breaking disappointments came to a turning in a partnership with Mr. Boulton of Birmingham; and in a very short time, their Soho works became famous for its engines.

James Watt lived until his 83rd year—years crowded with effort to economize labour in many departments of life; for in addition to his steam-engine inventions, he found time to devise a spiral oar to improve the propulsion of boats, a steam road-car, a letter copying-press, a regulator lamp, a linen-drying machine, a plan for warming buildings by steam, and an instrument for measuring the specific gravity of liquids. Even when he was seventy-five he suggested a means of conveying water-pipes across the irregular bed of the Clyde, a task that had defied all the best engineers of the day. Finally, when the great Reaper came to still the busy brain for ever, the old man was engaged upon a machine for reproducing facsimile copies of busts and statues.

Watt was buried in Handsworth church, which is within sight of the stacks of the great engineering works of all kinds, which have made Soho renowned all the world over; but in Westminster Abbey there is a statue, the work of Chantrey, upon the pedestal of which is inscribed a noble epitaph :—

Not to perpetuate a name,
which must endure while the peaceful arts flourish,
but to show
that mankind have learnt to honour those who best deserve
their gratitude,
THE KING,
his ministers, and many of the nobles and commoners of the
realm, raised this monument to
JAMES WATT,
who, directing the force of an original genius,
early exercised in philosophic research,
to the improvement of
THE STEAM-ENGINE,
enlarged the resources of his country, increased the power of
man, and rose to an eminent place
among the most illustrious followers of science and the real
benefactors of the world.
Born at Greenock, MDCCXXXVI.
Died at Heathfield, in Staffordshire, MDCCCXIX.

The steam-engine having at length passed out of the region of speculation, we may very well endeavour to grasp the principles of steam-power without going into abstruse technicalities that would only bewilder and confuse.

Water boils when heated to 212 degrees at the ordinary pressure of the atmosphere (15 lbs. per square inch), and is converted from the liquid into the gaseous state, when it passes off as steam. If the steam, or water vapour, be robbed of its heat, it is condensed and reconverted into drops of liquid water.

Let us fully understand what is entailed in the process of boiling. Suppose we have a vessel containing 19,999 cubic inches, no matter what tremendous pressure be exerted, the vessel cannot be made to hold more than one additional cubic inch of water—in other words, 20,000 cubic inches of water may be compressed into not less than 19,999 cubic inches. Now turn attention to the force of steam as it rushes out of the spout of a kettle standing upon a fire. In the great change which the water has undergone by the application of heat, it has expanded to 1700 times its original bulk, which means that a cubic foot of water makes 1700 cubic feet of steam, or almost sufficient to fill a room 12 feet square and 12 feet high.

Water, as we have noted, is practically incompressible, but steam can be packed into a very small space. If we seal up the lid and spout of the kettle, we know that the expansive force of the steam will at length shatter the metal; but not until hundreds of cubic feet are in confinement, and the stronger the kettle the more steam it will hold before the explosion takes place. In the use of steam as motive power it is necessary to keep it under strict control; the strength of the boiler has to be known; and before the danger point is reached the excess steam must pass away of its own accord.

Experiment.—Place a small quantity of water in a glass bulb having a long neck, the same size throughout. Any long-necked flask, or even an ordinary test-tube, will serve the purpose. Into the neck or tube fit an air-tight piston, so that it will move freely up and down. If a flame is applied to the bottom of the flask, the water will boil and form steam, the expansive force of which will raise the piston. Immediately this happens, dip the flask or tube into cold water, and notice that the piston promptly falls again. No matter how many times this operation is repeated the piston always will rise as the water boils, and always will fall as it is cooled. It is very evident that it rises because the expansive force of the steam overcomes the pressure of the atmosphere on its upper surface. But why does it fall? The cooling process condenses the steam into drops of water, which occupy less space than the steam. Consequently a vacuum is formed, the pressure of the atmosphere reasserts itself and forces the piston down again.

Here we plainly see the vital principle of the steam-engine, which consists indispensably of a cylinder fitted with an air-tight piston, which works up and down, or backwards and forwards according to arrangement, by the force of the steam. The difference between the experimental tube and the engine cylinder is, that in the latter the movements of the piston are caused by steam only, without the assistance of the atmosphere.

Now let us proceed to examine a very simple vertical engine. From the boiler the steam passes along a pipe to a box which is called the valve-chest. In the opposite side of this chest are three holes; the first communicates with the top of the cylinder, and the third with the bottom, while the second or intermediate aperture is in communication with a chamber which is called the condenser.

Working in front of the three apertures is the slide-valve, a smooth, flat piece of steel that is sufficiently long to cover the centre hole and one of the others; and thus, if the top hole is covered the bottom one is always open, and *vice-versa*. It is not difficult to understand the reason for this. The piston has got to be moved by the steam, and if both the top and bottom apertures, or steam-ports, were open at the same time the steam would enter the cylinder on both sides of the piston, and equal pressure on either side would result in no movement.

When the slide-valve closes the bottom steam-port, the top one is open and the steam rushes into the cylinder to force the piston down. In the meantime the slide-valve moves up, closes the top aperture and opens the bottom port to allow of the admission of steam; while the steam that has done its work in the upper portion of the cylinder passes through the exhaust-port into the condenser, allowing the piston to be forced up because the opposition has been removed. The rising of the piston brings the side-valve down again; and the same movements being repeated, the piston is in a continual state of motion.

Probably the majority of the engines that the reader may have an opportunity of examining at work will appear to be much more complicated than the one just described; but all else are but additional fitments, or variations attached to the great principle that has been explained. There are, for example, various types of valve; some rise and fall instead of sliding, others have a rotary movement such as the Corliss valve, in which case there are four ports, two admission and two exhaust. Another very important apparatus is the governor, which regulates the admission of steam to the cylinder; and here again there are as many types of governor as there are of steam valve.

A Simple Engine is one that is worked by a single cylinder; but in modern high-pressure engines there may be four cylinders, through each of which the steam passes before it finally escapes as exhaust steam. This method of utilizing the steam a second, third, or fourth time is known as "compounding," and the engines are called compound or multiple cylinder engines, the cylinders in each case being denoted in their titles, double-expansion, triple-expansion and quadruple expansion. By compounding there is less loss of heat from cylinder condensation; it follows that more energy is extracted from the steam before it escapes into the atmosphere; and economy of steam means a saving of fuel, with a general increase of efficiency in the engine of something like twenty per cent.

CHAPTER III

THE PIONEERS OF STEAM TRACTION

IF we were asked to name one of the greatest triumphs of Steam, it is safe to assert that our thoughts inevitably would fly to the locomotive railway engine, if only because it is so much in evidence even to the casual observer, while it is very common knowledge that it has worked a peaceful revolution in human affairs.

George Stephenson is often regarded as the parent of the locomotive engine, but long before his time steam carriages had been at work, and indeed locomotives were known while he did but dream of them. In the case of steam traction, just as with the steam-engine generally, many men were groping their way to attain the same end. One man would meet with total failure and another would attain but a very indifferent success; and finally one feature of the failure would be utilized to change the partial into complete success. We shall see that the locomotive was not the product of one brain but of

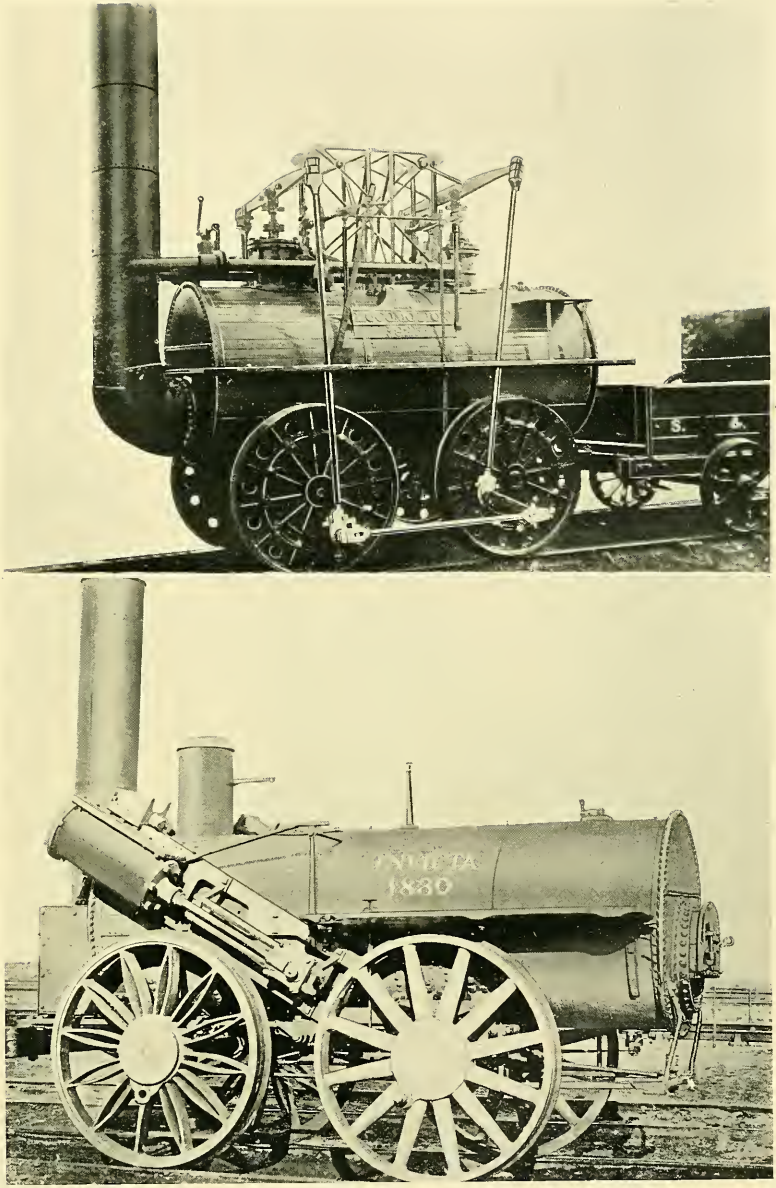


PLATE I.

1. "LOCOMOTION" (1825). 2. "INVICTA" (1830).

many ; and it fell to Stephenson's genius and capacity to put the seal, not only upon his own patient effort, but that of other men.

Sir Isaac Newton was the first man to make a "road-engine." He evolved a most primitive contrivance, little better than a tea-kettle on wheels, for it was but a wheeled vehicle with a circular boiler in the middle. Nevertheless the notion was there, although nearly a century and a half would elapse before the idea developed into practical form.

James Watt paid more than a little attention to steam traction. Only three years after he regretted that he had done no good in the world, he patented a steam-carriage; and his model, which worked with considerable success, may still be seen in South Kensington Museum. The engine was what was known as the "grasshopper" type, because a beam, moving up and down, somewhat resembles the leg of that insect.

In the United States Oliver Evans was experimenting with steam waggons. He was quite confident that steam could be utilized as traction power. He declared that his engines would not only draw waggons on turnpike roads, but would propel boats against the current of the Mississippi. "The time will come," he said, "when people will travel in stages, moved by steam-engines, from one city to another almost as fast as birds can fly—

fifteen to twenty miles an hour. Carriages will start from Washington in the morning, passengers will breakfast at Baltimore, dine at Philadelphia and sup at New York in the same day." What would the prophet say, if he could revisit the scenes of his labours and witness an express travelling between Atlantic City and Philadelphia at the rate of 70 miles an hour?

In the year 1801 Richard Trevithick, a pupil of Murdock who had had the advantage of acting as assistant to James Watt, constructed a locomotive engine and achieved the feat of carrying passengers by steam power for the first time. In partnership with Andrew Vivian, he built another engine and ran it along nearly the hundred miles of roads that lie between Camborne and Plymouth.

When this engine had been improved, in 1804 it was used to draw coal-trucks upon a tram-road at Pen-y-Darn mine, near Merthyr Tydvil; but coal-trucks had been drawn on a wooden railway at Newcastle as early as 1602, and an iron railway for the same purpose was in existence near Sheffield in 1776.

Trevithick's ambition aimed at something more than the carriage of coal. He constructed a circular railroad in a field near where Euston Station is now situated, and ran a steam carriage to the amazement of all the sight-seers, who eagerly paid for admittance. In this crude experiment Trevithick showed that smooth wheels would grip smooth rails, and that there was no necessity for cogwheels and toothed rails, which many engineers maintained railway locomotives would need. One day, however, the engine was thrown off the rails, and the inventor's funds would not permit the restoration of the line to resume operations.

About this period locomotive engineers were exceedingly busy. William Hedley built "Puffing Billy," a "grasshopper" with four smooth wheels and vertical cylinders; others still pinned their faith to toothed wheels or chains; and one fantastical engine even walked upon metal legs. Within very recent years we laughed at the troubles of the early motor-car drivers, but their tribulation was mild compared to the woes of the railway pioneers. Their steam road-engines not only came to grief in a variety of ways, but there was much opposition to their use. The engines snorted and shrieked, distracted the cattle in the fields, and the sparks set fire to dry grass, hedges and hayricks; and claims for damages were a very serious item to an inventor, even if he had a wealthy patron at his back.

"Puffing Billy," however, was not meant for the public highway; it was installed at Wylam colliery, Newcastle, where it hauled eight loaded coal waggons at ten miles an hour, thus doing the work of ten horses. A little later Hedley found that his four-wheeled engine frequently broke the light rails then in use, and he, therefore, mounted it upon eight wheels, in which form it worked satisfactorily for many years.

William Hedley indubitably proved that the weight of an engine would cause it to adhere to the rails, and that friction alone would insure progression without slipping ; he improved the exhaust pipe so as to intensify the blast—and his engines were drawing trains of trucks quite a year before Stephenson constructed a locomotive. William Hedley was the real father of the Locomotive and of British Railways, although after the perusal of a few more pages we may be prepared to admit that George Stephenson was at least a stepfather—and a very good stepfather, too.

When "Puffing Billy" was patented, Stephenson was thirty-two years old. He was the son of a workman in a colliery at Wylam, and at eight years of age was minding cows for the munificent sum of twopence a week. His lowly occupation left him with much time on his hands, and young Stephenson spent much of his leisure in constructing model engines with clay. Shortly the boy went to work at the mine as a "picker," removing stone, dross and other impurities from the coal ; and in course of time he was employed in helping to fire the engine, which drew the coal up to the surface.

At seventeen years of age Geordie Stephenson was appointed engineman; he was full young for the post, but he set himself to learn all there was to know of the construction of the engine. He could neither read nor write, and, all the books dealing with the subject being closed to him, he had to puzzle out things for himself, and this he accomplished by taking the winding engine to pieces and fitting it together again.

Geordie was never tired of listening to descriptions of the wonderful engines of different kinds that were made by Boulton and Watt; and he determined to educate himself that he might read about them without being dependent upon others for his information. He promptly attached himself to a night school, where by wonderful perseverance he speedily out-distanced all the other scholars, especially in arithmetic. His wages were small, and in order to earn more money he took up shoe-mending at night; and later on he was the best clock-mender in the district.

From Wylam Stephenson moved to Montrose to a better-paid situation, which he lost through his inquiring turn of mind. The engine of which he was in charge did not work satisfactorily, and the rough workman attempted to improve it. It was a task that would have tested James Watt, and little wonder that the inexperienced engineer only made matters worse. With £28 in his pocket

Stephenson returned to Newcastle—and so as not to break in upon his little store of money, he travelled the whole distance of two hundred miles on foot.

When he resumed work in the Newcastle district, he could not flatter himself that he had yet proved very successful from an engineering point of view. In addition, he had lost his wife; he had to support a blind father; and he had no money with which to give his son, Robert, the advantages of a good education, of which from bitter experience he knew the value.

The opportunity was at hand, however, for Stephenson to show his mettle. A pumping engine at the pit where he was employed failed completely in its work, and a whole year was wasted by various engineers in attempting to remedy the defect. Stephenson boldly declared that he knew what was wrong, and eventually, in despair, the manager gave him permission to attempt in succeeding where others had failed. In five days the pumps were set in action, and in twenty-four hours the mine was dry, and on the spot Stephenson was rewarded with £10. That was the turning point, for his fame spread throughout the district; and he was the doctor who was called to attend to numerous sick engines.

Stephenson now began to know the meaning of happiness. He received an appointment as colliery engineer at Killingworth and could afford to send Robert to a better school; and when his day's labour at the mine was completed, he would return home to work mathematical problems with the boy who had inherited his father's genius.

Now it was that Stephenson turned his thoughts to the locomotive. He had been forming ideas upon the subject, but when he saw William Hedley's engine he perceived that he was far behind in the race. But the best locomotive then known was faulty in the extreme, and Stephenson set himself to the task of improving it. He laid before the proprietors of the mine the plans for a "travelling engine," and eventually Lord Ravensworth undertook to defray the expenses of the experiments.

Stephenson's first engine was, at any rate, not a failure; it drew eight loaded waggons at a pace of four miles an hour. The inventor perceived that he needed to generate steam more rapidly, and in a new engine he accomplished it by utilizing the waste steam. Instead of ejecting it into the air, he allowed it to escape into the chimney to improve the blast and increase the intensity of the fire. Even then the engine was not a complete success, but Stephenson was assured that time and never-ceasing experiment would overcome all obstacles.

Although it has no actual bearing upon the locomotive, one incident in the career of Stephenson must not be omitted, if only to show the dogged perseverance of the man, and the almost sublime faith he had in his inventions. Having constructed a safety lamp for use in gas-laden mines, he went down a specially dangerous pit, and thrust his lamp into a current of explosive air—and the flame flickered out without any explosion. Next he solved the problem of how to keep the flame alive, and the "Geordie" lamp was in use in the northern coalpits before Sir Humphry Davy exhibited his famous lamp to the Royal Society.

The public awarded the palm to the scientist, but Stephenson's friends were not satisfied with the £100 reward, which was all the inventor of the "Geordie" lamp received as a mark of appreciation. As the result of an agitation in his favour, Stephenson was presented with a silver tankard and a thousand guineas, but for which Robert Stephenson would not have gone to a college in Edinburgh to complete an education, that would stand father and son in good stead in the years to come.

There was a general demand for steam carriages to travel along the King's highway, but Stephenson resolutely confined his attention to the railed-road. The locomotive at the Killingworth mine now worked so well that the proprietors of Hetton colliery decided to lay down a line of eight miles. The work was placed in Stephenson's hands, and on the 18th of November, 1822, the Hetton railway was opened with a display of several new engines hauling heavily loaded waggons.

Enthusiastic advocates of the railed-road were discussing the feasibility of connecting Liverpool and Manchester; but the opposition of the land-owners alone, for a time at least, called for the abandonment of the idea.

In the meantime, Mr. Pease of Darlington procured the necessary Act of Parliament to construct a tram-line from Darlington to Stockport, along which to haul coal by means of waggons and horses, although the Bill was worded "by men, horses, or otherwise." Mr. Pease experienced quite a shock when George Stephenson, an "engine-wright," called to see him with the suggestion that steam traction be adopted on the new line. Pease happened to be a large-hearted, energetic man. He was very much impressed by Stephenson's earnestness, and visited Killingworth to see his engine at work. The result was that he persuaded his friends to construct a rail-road instead of a tram-line, and when Parliamentary consent was obtained George Stephenson was appointed engineer.

At this time Robert Stephenson, though only twenty-one years old, was his father's right-hand man; and father and son threw themselves into the work, heart and soul. Unfortunately, Robert's health broke down and, a change of climate being absolutely necessary, he accepted a post at a silver mine in South America. If the new engines had not been nearing completion, Stephenson senior would have found his plans very seriously impeded, for no young engineer of Robert's capacity could be found to replace him.

Though Mr. Pease believed thoroughly in George Stephenson, he could not persuade his fellow-directors to order more than three locomotives, and they even bought a large number of horses, which they firmly believed would be called upon to assist the engines. Stephenson only smiled at the unbelievers, while he prepared for their conversion in a manner that would surprise them. He decided that, when the train of waggons made its first trip to Stockton, a passenger carriage should be attached just to show that rail-road traction might very well concern itself with something more than the conveyance of coal or merchandise.

The directors grudgingly agreed to this whim on Stephenson's part. They already viewed him largely as a visionary; but if they had heard his words to Robert and a young friend, on the eve of his son's departure for America, certainly they would have classed him as a dangerous lunatic. Said he: "I may not live to see it . . . but the railway will be the great highway for the whole Kingdom. . . . It will be cheaper for a working man to travel by rail than to walk on foot. It will drive every coach off the road, and will be the one great means of conveyance, whether for the King or his people."

The 27th September, 1825, was an auspicious day in the industrial history of the world. Vast crowds gathered to witness the "great blow-up." Stephenson's admirers stepped up not only into the passenger carriage, but into the coal waggons. Stephenson himself was the driver of No. 1 engine, Locomotion (Plate I), which shrieked and set off at the alarming speed of twelve miles an hour. All along the route the excitement was intense; and at the Stockton end of the line was another multitude, scarcely daring to hope for anything better than news that the engine had broken down somewhere on the way. Their fears, however, were groundless. The engine answered all expectations, and the proud inventor stepped down from his snorting, fiery steed to receive the heartiest of popular acclamations.

The Liverpool and Manchester railway project was revived, and in due course Parliament sanctioned the construction of the line. Stephenson was called upon to give evidence before a Committee of the House of Commons. He was asked, whether it would not prove a very awkward circumstance if a cow strayed on to the line in front of one of his engines, when travelling at the rate of nine or ten miles an hour. With a humorous twist of the lips, he replied: "Yes, very awkward—*for the coo.*" It was also put to him that men as well as animals would be frightened by the red-hot smoke stack; but Stephenson suggested that they might think it was *painted*, in which case they would have no fear.

Whatever effect Stephenson's evidence had on the Committee, he did not convert a writer in the *Quarterly Review*, who said: "What can be more palpably absurd and ridiculous than the prospect held out of locomotives travelling *twice as fast* as stage-coaches? We would as soon expect the people of Woolwich to suffer themselves to be fired off upon one of Congreve's rockets, as trust themselves to the mercy of such a machine, going at such a rate."

The very idea of a line thirty miles in length caused something like a panic all along the suggested route, and endless objections were raised. It was said that the fumes from the engine would poison the air; cattle would be stampeded, and if they did not die of fright, they would at least break their legs in their desire to escape from the fiery monster; horses engaged in vehicular traffic would take fright; life and limb would be endangered to a perilous extent; and, in short, the railway men were engaging in an impious undertaking for which Providence would assuredly punish them.

The rails were at length laid; even Chat Moss, a miry bog, was made firm enough to support the permanent way. Nevertheless, it was not definitely decided how the line should be worked. Stationary engines at intervals along the line were suggested to draw the waggons by means of ropes. Stephenson was almost distracted. When he was appointed engineer, he had taken it for granted that locomotives would be used; but only after a great deal of persuasion did the directors consent to give the locomotive a trial. Forthwith all the locomotive engineers in the Kingdom were at work upon new engines to compete for pride of place on the new line. Robert Stephenson returned to England to assist his father, and at their Newcastle engine-works a new engine, the "Rocket," was speedily under construction.

Four engines complied with the Company's requirements; and at Rainhill a line two miles in length was laid, upon which each engine was to make twenty trips at ten miles an hour. The "Sanspareil" (Mr. Hackworth) broke down on the eighth trip; the "Novelty" (Messrs. Braithwaite & Ericsson) burst; and the "Perseverance" (Mr. Burstall) speedily proved to be a failure. Not only its own fate, but that of steam traction generally, depended upon the "Rocket," and nobly Stephenson's engine came through the ordeal; for not only did it accomplish 29 miles an hour, but was as easy to handle as the gentlest children's pony.

Meanwhile the Canterbury and Whitstable line had been opened. The first engine was the "Invicta," a sister to the "Rocket" (Plate I).

On September 15th, 1830, the Liverpool and Manchester line was formally opened. The Duke of Wellington, who was then Prime Minister, and several members of the Government were present at the ceremony. The "Northumbrian," with George Stephenson as driver, drew the Duke and his party; the "Phœnix," with Robert Stephenson at the lever, followed with many distinguished visitors, and other engines drew carriages that were loaded to their utmost capacity.

The procession left Liverpool at the rate of 20 miles an hour, and continued that speed until it reached Parkside, half-way to Manchester; where a halt was called, that the Prime Minister and his friends might review the locomotives in order to note their points of excellence.

It was a pity that the journey was interrupted. Mr. Huskisson got out of his carriage to speak to the Duke, and before he could regain his seat the "Rocket" approached at a rapid rate. In his confusion the gentleman slipped, fell upon the line, and before it could be drawn up the engine crushed his leg to pieces. In a dying state the first victim to the "iron-horse" was conveyed the fifteen miles to Liverpool in twenty-five minutes, where, notwithstanding the best of medical treatment, he died the same evening.

This unfortunate occurrence not only cast a gloom upon the opening ceremony, but it gave a handle to the pessimists which they were not slow to seize; and for quite a long time people viewed the railway with suspicion and mistrust.

When the trains at length arrived at Manchester a vast concourse of people swarmed upon the line, not alone to see the engines but the man, who only fifteen years earlier had won a battle that had changed the history of nations. The battle which George Stephenson had won was widely different in character from that of Waterloo, but, nevertheless, it was one of the greatest victories the world has ever known.

The return journey to Liverpool was marked by a *contretemps* that was more amusing than serious. So great was the multitude and so embarrassing its attentions, that it was decided the Duke should return earlier than had been arranged.

Four of the engines had gone four miles along the down line for water, and the Duke's train cut off their return to Manchester; and thus the four light engines had to run ahead all the way to Liverpool, leaving at Manchester only three engines to work back trains which had been drawn by seven.

Notwithstanding the regrettable accident to Mr. Huskisson or the delays in the return journey, the triumph of the locomotive was established; nothing could now retard its progress in the service of man.

In conclusion, several points of special interest may here be mentioned. Trevithick's locomotive a quarter of a century earlier had hauled ten tons of iron and seventy passengers, but had not proved a commercial success; whereas Stephenson demonstrated that the railway was capable of earning dividends for those people who would invest money in the new undertakings.

Concerning the engines, it is doubtful whether, but for some trifling defect, Hackworth's "Sanspareil" would not have been the victor at the Rainhill trial. In any case it contained a most important principle; its driving wheels were coupled, and on this subject much will be said in later pages. The "Rocket" was an outside-cylindered engine; but in the "Planet" Stephenson placed the cylinders inside the frames; and the driving wheels were in front of the fire-box instead of being attached to the smoke-box end of the boiler. For quite fifty years British locomotives were but variations of the "Planet" type.

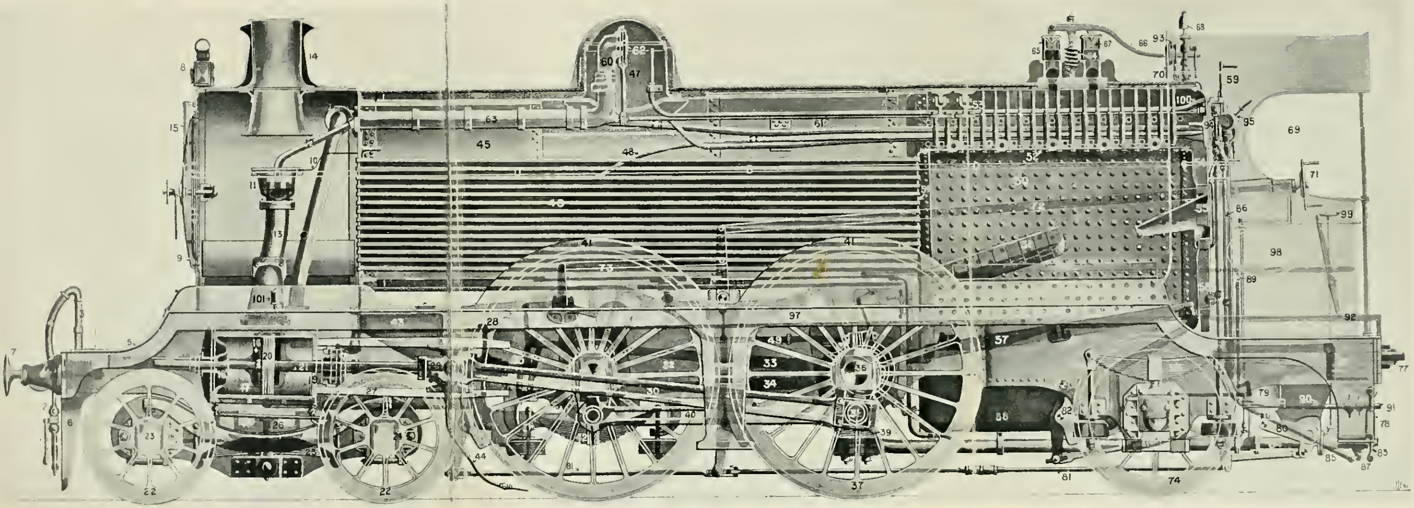


PLATE II

ATLANTIC TYPE LOCOMOTIVE.

1. Buffer Beam.
2. Screw Coupling.
3. Vacuum Brake Pipe.
4. Vacuum Brake Hose.
5. Front End Plate.
6. Guard Iron.
7. Buffer Head.
8. Lamp.
9. Smoke Box Door.
10. Spark Arrester.
11. Blower.
12. Blower Pipe.
13. Blast Pipe.
14. Chimney.
15. Hand Rail.
16. Steam Port.
17. Cylinder.
18. Cylinder Front Cover.
19. Cylinder Back End.
20. Piston.
21. Piston Rod.
22. Bogie Wheel.
23. Bogie Wheel Axle.
24. Bogie Wheel Axle Box.
25. Bogie Spring.
26. Bogie Pin.
27. Slide Bar.
28. Motion Plate.
29. Cross Head.
30. Connecting Rod.
31. Crank Pin.
32. Inside Frame Plate.
33. Eccentric Rod (Fore Gear).
34. Eccentric Rod (Back Gear).
35. Expansion Link.
36. Driving Axle.
37. Driving Wheel.
38. Driving Wheel Balance Weight.
39. Driving Wheel Springs.
40. Side Rod.
41. Coupled Wheel Splashers.
42. Coupled Wheel Spring.
43. Sand Box.
44. Sand Pipe.
45. Boiler Shell.
46. Boiler Tubes.
47. Dome.
48. Internal Delivery Pipe.
49. Blow-off Pipe.
50. Fire Box.
51. Fire Box Tube Plate.
52. Fire Box Crown.
53. Fire Box Crown Sling Stays.
54. Fire Box Water Space.
55. Fire Door.
56. Brick Arch.
57. Fire Bar.
58. Mud Door.
59. Regulator Lever.
60. Regulator Head.
61. Regulator Rod.
62. Regulator Slide Valve.
63. Steam Pipe.
64. Safety Valve Spring.
65. Safety Valve Columns (four).
65. Safety Valve Spring.
67. Safety Valve (four).
68. Whistles (two).
69. Cab.
70. Cab Window.
71. Reversing Wheel.
72. Reversing Rod.
73. Reversing Rod (intermediate).
74. Trailing Wheel.
75. Trailing Wheel Spring.
76. Trailing Wheel Spring Hanger.
77. Tender Buffers.
78. Safety Chain.
79. Steam Brake Cylinder.
80. Steam Brake Lever.
81. Brake Pull Rods.
82. Brake Block.
83. Exhaust Steam Injector.
84. Exhaust Steam Pipe to Injector.
85. Exhaust Steam Injector Overflow.
86. Live Steam Injector, Steam Pipe.
87. Live Steam Injector, Overflow.
88. Ash Pan.
89. Damper Rod.
90. Feed Water Pipe.
91. Feed Water Hose.
92. Foot Board.
93. Steam Gauge.
94. Water Gauge.
95. Vacuum Brake Valve.
96. Train Pipe.
97. Outside Angle Iron.
98. Number Plate.
99. Water Regulator to Injector.
100. Steam Pipe to Injector.
101. Cylinder Lubricator.

CHAPTER IV

THE CONSTRUCTION OF THE LOCOMOTIVE

TO the casual observer the locomotive-engine appears to be the most complex thing imaginable, but when all is said and done it is but a steam-engine upon wheels. With a full grasp of what was explained in Chapter II., we ought not to experience much difficulty in understanding a very great deal of the monster that hurtles along the gleaming metals at the rate of sixty miles an hour. At the outset it may be said that a locomotive consists of three parts: in the boiler and fire-box is generated the power; the cylinders and valve-gear utilize it; and the wheels convert the whole machine into a self-propelling carriage, capable of moving backwards as well as forwards, powerful enough to move a tremendous weight slowly, and yet possessing the capacity for rapid motion.

The Fire-box

It is the heat in the fire-box applied to the water in the boiler that generates the steam, and thus is the source from which is directly derived all the necessary power. Consulting the illustration of a longitudinal section of a locomotive (Plate II) we first note the fire-box, which consists of two portions, the "inner" and the "outer fire-box." Attached to the cylindrical portion of the boiler is the outer box with a top that may be semi-circular or flat as in the illustration; and this contains the inner box. In simple language we have one box placed within a larger one, and the spaces between them, being in communication with the boiler barrel, are consequently filled with water. An observant boy will at once draw attention to the fire-hole or the opening through which the fuel is shovelled into the fire, and ask what becomes of the water space at that point. The water space is carried round the fire-hole, or there could certainly be no water below the level of the foot-plate.

The fire-grate and the ash-pan scarcely need description. The bars are arranged longitudinally with sufficient spaces between them to allow a free draught in order to admit of the perfect combustion of the fuel. The ash-pan is fitted with dampers at the front and back. By means of rods and levers the driver can open or close or regulate the dampers, as best suits the fire and the particular circumstances under which the engine is travelling. Harking back to the fire-box for a moment, we see a brick arch, which deflects the gases arising from the fire, and causes them to circulate more thoroughly about the box than would otherwise be the case.

The barrel of the boiler consists of bent steel plates riveted together, and the rings may be either telescopic in pattern, or they may be quite parallel throughout; while a few very modern boilers are tapering in shape. Inside the boiler barrel are tubes, varying in number from a hundred to two hundred and fifty, extending from the fire-box to the smoke-box. The tubes are of iron, steel, brass or copper; and as the hot gases pass through them on their way to the stack, they rapidly become heated, and, transmitting the heat to the water, quickly convert it into steam. In the water space between the inner and outer fire-boxes steam is heated even more quickly, because this water is exposed more directly to the greatest heat. The sides and top of the inner-box and the tubes form the heating surface, and the constructor of engines ever seeks to obtain as much heating space as possible, so as to increase the steam-raising capabilities of the boiler to the fullest extent.

The dome on the top of the boiler barrel is only a steam reservoir, in which to collect steam well up above the water level. The steam in the dome is drier than elsewhere, and dry steam is capable of better work than steam largely mingled with water. For this reason the regulator valve is situated in the dome, and this controls the steam that is admitted to the cylinders. From the dome the "dry steam pipe" extends to the smoke-box, where the supply pipes to the cylinders are connected up to it. They encircle the smoke-box, where the great heat exerts a drying influence before the steam passes on to the cylinders.

The question of dry steam being of the greatest importance, those engines that have no dome are supplied with a "steam collecting pipe," perforated along the top, which is placed inside the top of the barrel above the water level, and in this case the regulator valve is in the smoke-box. Yet other engines are fitted with a "superheater," which dries the steam by ridding it of its saturation or moisture.

A common and useful type of regulator valve for dome use is one in which a cylindrical valve is lifted off its seatings by a rod which is raised or lowered by the driver in the cab by means of a connecting rod. The steam enters at the top, passes through the body of the valve, and enters the pipe from both the under and upper sides of the valve.

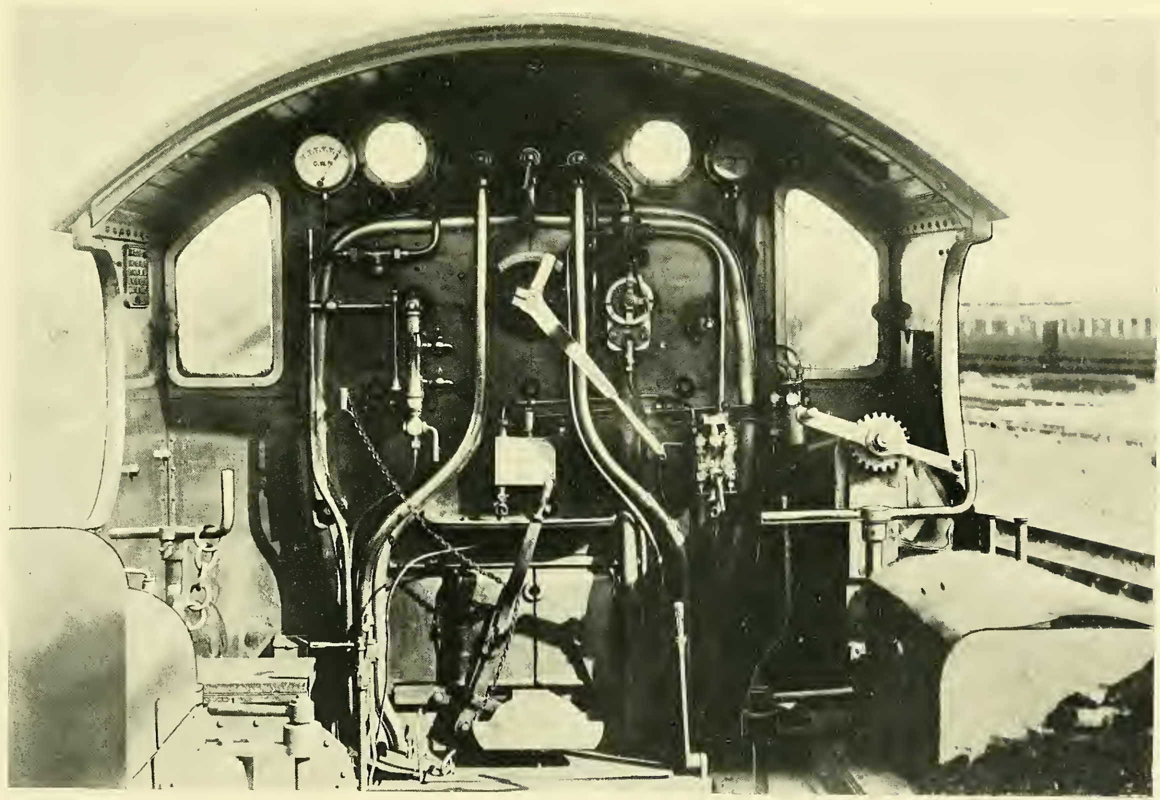


PLATE III.

INTERIOR OF CAB. G.W.R. "KNIGHT OF THE THISTLE" (4-6-0).

The safety-valve is generally situated over the fire-box, but in domeless boilers it is often placed where the dome would otherwise be upon the middle ring of the boiler barrel. The Ramsbottom valve is a popular type of safety-valve. Connected with the boiler at their base are two hollow pillars whose tops are closed by the valves themselves, which are united by a lever, while a spring holds them down upon their seats.

In early days, with wrought-iron boilers, only a pressure of 60 lbs. could be obtained, whereas with modern steel boilers a pressure of 235 lbs. per square inch is often used, and British locomotives ordinarily work with a pressure of from 175 to 200 lbs. The valves are "loaded" so that they will not blow off at anything below the desired pressure. By screwing up a nut the tension of the spring can be adjusted to keep the valves down on their seats until, say, a pressure of 175 lbs. is attained. When that point is reached a needle will indicate the figure on the pressure gauge in the driver's cab, and will automatically release the valves and allow the excess steam to blow off into the atmosphere.

The smoke-box occupies the forward end of the boiler. We already know that it contains the supply pipes to the cylinders, but there is also the blast pipe by means of which the exhaust steam from the cylinders escapes into the chimney. Sometimes the smoke-box holds other minor contrivances such as the "spark arrester," to minimize the too free emission of sparks which lead to conflagrations along the sides of the line, notably setting fire to dry grass, haystacks, barns, etc.

The blast pipe is generally fitted with a "blower" of which there are several types. The mouth of the pipe is encircled by a perforated pipe to which steam is brought from the dome. The driver has but to turn a handle in the cab for steam to rush along the pipe, through the perforations and so up the chimney. The blower's usefulness is called into play when a train is starting, at which point the resistance is tremendous, and the engine alone absorbs quite 35 per cent. of the power developed. The blower will give the fire the necessary fillip, for until the engine is in motion even the open dampers have little appreciable effect compared to when the engine is running.

In locomotives that have short chimneys outside, the stack is carried down into the smoke-box for the purpose of creating a better draught, and the smoke-box is often considerably extended with a view to provide a larger space for the collection of the ashes, which the draught draws through the tubes. This extended smoke-box also has the effect of decreasing "sparking," as the ejection of red-hot cinders into the atmosphere is called. The smoke-box has a circular door, working upon hinges, but capable of being screwed up very tightly.

Sometimes at a terminus a fireman may be seen with this door open, to allow him to clean out the tubes with a long wire brush.

Locomotive chimneys vary largely in pattern, but on the whole resemble each other fairly closely. In modern engines the chimney has grown shorter and shorter. The necessity for greater steam capacity has called for larger boilers; and with the increase in the height of the boiler there has been a corresponding decrease in the length of the chimney. The earliest locomotives could not raise sufficient steam, or if they raised it, they could not utilize it—and the finished product of to-day is ever calling for more steam as trains are constantly increasing in weight. Now larger cylinders will multiply the powers of an engine to almost any extent; but large cylinders alone are useless unless there is the extra steam to work them. There is a limit to the size of the boiler, for the bridges and tunnels of most of our railways were constructed generations ago and were built to accommodate the engines of their day, with what was then considered to be ample margin for increase in size in the future.

Those earlier calculations have been proved to be entirely wrong, and consequently the engineers of to-day have to cut their cloth according to the yard of yesterday. Boilers have about reached their limit in point of size, and for any further developments of power we must necessarily look to the more rapid conversion of water into steam. Reference has already been made to the heating surface of a boiler, which it is constantly sought to increase. Many famous British locomotives have had a heating surface of only about a thousand square feet, which some modern types have more than doubled.

The fire-box is not capable of enlargement, 6 feet 4 inches by 3 feet 6 inches being the limit of size that will not interfere with the driving wheels. In some recent engines on the London and South Western line sixty water tubes have been introduced into the fire-box, which give about 165 square feet additional heating surface; and in many fire-boxes the sides are corrugated to attain the same end. The boilers cannot be made higher without reconstructing thousands of bridges and tunnels, the cost of which would be enormous. Making the boilers longer would appear to be the obvious remedy. Greater length of boiler would permit the use of longer tubes, but the further a tube is removed from the fire-box the less its heating efficiency. But there remains a still more important consideration. The distance between the centres of the wheels rigidly fixed to the main frames is called the "fixed wheel base," and if this base were too long the engine would not traverse curves. In this country the maximum wheel base is about 16 feet, and this alone gives the answer in the negative to the suggested increase in the length of the boiler.

The Engine

Having discussed the generation of steam, we now follow it into the cylinders, which in the case of the locomotive may be either between or outside the main frames of the engine; and it may at once be noted that the cranks work at an angle of 90 degrees to each other, so that when one piston is exerting its full power, the other is at the end of its stroke.

In many engines the slide-valve gives way to the "piston" or cylindrical type, in which the resistance due to friction is reduced to a minimum. To describe the valve gear, by means of which motion is imparted to the valves, would not only be too intricate for our present purpose, but would necessarily occupy more space than can be afforded. The type that is used most extensively is the "shifting link motion." It was invented by Howe, one of George Stephenson's workmen, who sold the idea to his master for £20. With the exception of this invention, British locomotives have not really altered in general principle since about the year 1840.

In the Stephenson and Howe "link motion" an important part of the apparatus is the expansion link, which is connected by a rod with the reversing handle or wheel in the cab. If the link is lowered as far as possible and steam is supplied to the cylinders, the engine will move forward; if the link is raised, the engine will be reversed and will travel backwards. If the link is placed in *mid-gear*, the engine will not move because the valve will not admit enough steam to work the piston.

Observe an engine starting from a station, and the heavier the load behind it the greater will be the sound of the exhaust. But as the engine gets on the move the sound decreases, because having "linked up" the driver is now working with a smaller supply of steam. The "shifting-link" motion takes up too much room to be employed in locomotives, that use three or four cylinders working separate pairs of wheels, and in these cases the "Joy" gear is used, but it serves the same purpose as the "Stephenson and Howe" gear, and need not be described in detail.

In an earlier chapter, reference has been made to "compound" engines. Locomotive engineers are by no means agreed concerning the respective merits of compound and simple locomotives. Years of experiment and trial have failed to convert either supporters from their original opinions. There are three- and four-cylinder compounds, but in the simple locomotives it is not usual to multiply the cylinders, though there are three- and four-cylinder simple locomotives in constant use in the British Isles.

Most of the cylinders range from 17 to 20 inches in diameter by 24- and 26-inch stroke, which latter is the distance travelled by the piston in its passage from one end of the cylinder to the other. In low-pressure cylinders there is more variation, according to the class of engine to which they are fitted, 20½- and 30-inch diameter being perhaps the commonest sizes.

The engine and boiler of a locomotive are supported upon steel frames, which in turn are carried by wheels and axles. In the majority of locomotives, and practically in all of those which are intended for high speeds, the engine is supported on four large driving wheels, two on each side coupled together, while a bogie-truck with four small wheels carries the front of the engine. The truck is connected to the engine by means of a pin about which it can turn freely, much in the same manner that the two front wheels of a carriage turn independently of its body. The bogie, being able to swivel round the pin, can negotiate curves at a high speed, fitting itself to the curve, when rigid wheels would have a tendency to jump off the rails.

The wheels and axles are attached to the frames by means of springs. These vary in pattern, but serve the same purpose, viz. to minimize the shocks and concussions incidental to travelling at high speed, especially over points, although the engine and boiler are fastened as effectively as possible on to the frames, and all steam joints are well supplied with asbestos or metal "packing" to prevent leakage.

Locomotives engaged in long-distance traffic are fitted with tenders, which contain the coal and water with which to feed the fire and boiler *en route*, instead of stopping at various points to take in supplies. On some railways fast trains pick up water, while the train is running at full speed. Into a long water-trough, laid between the metals, the driver lets down a pipe with a hinged scoop facing ahead, with its mouth below the surface of the water. There is no need of a pumping contrivance of any kind; the scoop, being forced through the water at a rapid rate, sends the liquid up to the storage tank in the tender, from which it is fed into the boiler by means of a steam "injector." The water of itself could not force its way into the boiler, but the steam gives it sufficient momentum to overcome the pressure opposing it.

The reliability of the wheels of a locomotive, as readily may be imagined, is of the utmost importance. A pair of wheels has not only to support an axle bearing a weight of sixteen tons or more, but they have to endure the strains invariably associated with powerful motion, accommodate themselves to any imperfections in the road, the jolting over points, and especially to withstand the pressure upon the flanges, or projecting edges of the tyres, in going round sharp curves. In passing, it may be mentioned that in the earliest railway practice the rails were flanged instead of the wheels. The wheels, which are invariably of steel, are forced on to the axles by hydraulic pressure; keyways are cut partly in the axle and partly in the wheel and steel keys driven in; and the crank pins are pressed hydraulically into the wheels, thus giving the whole the utmost solidity that human ingenuity can devise.

A locomotive is fitted with several brakes; a steam-brake works upon its own wheels, and a hand-brake works upon those of the tender. But on every passenger train there has to be a continuous automatic brake, to which reference will be made in later pages.

Having now discussed the main features in the construction of the locomotive, we may refer briefly to the "sanding gear." Wet or frosty weather has a marked effect upon the rails; and the wheels of the engine fail to get the necessary grip, especially when starting from rest. On either side of the locomotive are fixed sand-boxes from which pipes extend very closely to the rails. The driver works the gear from the cab, the sand being dropped upon the rail directly under the tread of the tyre; and upon the roughened surface the wheel secures the grip necessary to effect a start. The sand often falls only by gravity, but compressed air or steam more frequently are employed to sand the slippery metals.

Many important parts of the locomotive have not been mentioned even, but a careful study of the excellent illustrations (Plates II and III) will enable the reader to grasp various points better than could be afforded by mere verbal description.

CHAPTER V

THE LOCOMOTIVE

Some Types and their Feats

HAVING devoted considerable space in examining the construction of the locomotive, we may now take a survey of the completed machine, noting variations in form and arrangement, not only between the engines used by different railway companies, but some at least of the many distinctions between the engines at work upon the same railway system. It will be impossible to review all the numerous divisions and subdivisions in type, but we may obtain a very good idea of the chief classes of locomotive engine that work the traffic on any of the lines in the British Isles, with which we are principally concerned.

The distinguishing feature of a locomotive rests in the number and position of its wheels; and no boy can travel far on any railway, or stand for any length of time upon a station platform, without desiring to know why engines display such varied wheel arrangements.

If locomotives all had to perform the same class of work, their wheels would be very much alike instead of some having six, eight, ten or even twelve wheels. One engine is built specially to draw a light express train at a great speed over a level tract of country; a second has to pull a similar train up long and severe gradients; while a third has to haul a long suburban train with every seat occupied, stopping at many stations and requiring to get up speed as soon as the guard blows his whistle. On the other hand, a goods engine must be a very giant in haulage, but speed need not necessarily enter into calculation.

Passenger Locomotives

(Plates IV and V)

Passenger train engines have larger wheels than those engaged in goods traffic; the former may have one pair of driving wheels or two pairs coupled together, whereas the goods engine will probably have three or four pairs of same-sized wheels all coupled. The small goods-engine wheels revolve more quickly at any given speed, and the cylinders can apply fresh power more frequently; but the larger the diameter of the wheels, once the initial effort of starting has been overcome, the easier it is to attain high speeds.

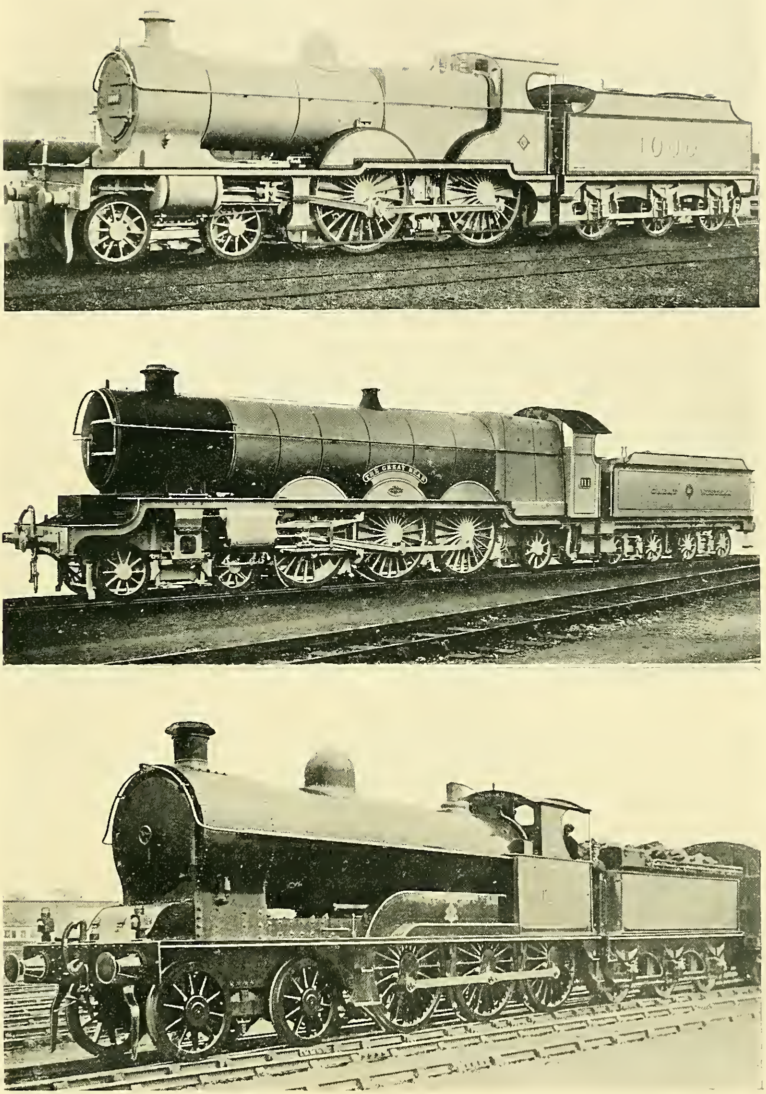


PLATE IV.

EXPRESS LOCOMOTIVES.

1. M.R. (4–4–0). 2. G.W.R. (4–6–2). 3. L. & N.W.R. (4–6–0).

Twenty-five or thirty years ago express locomotives had only six wheels, and because they relied upon one pair of driving wheels they were designated "singles." Increasing weight in the train loads found the "singles" wanting in sufficient adhesive weight to haul heavier trains than to which they were accustomed, and some modifications became necessary. The engineers overcame the difficulty by reducing the size of the driving wheels, while they made the trailers of equal diameter and coupled them to the drivers. Simply making the wheels of the same size would not have effected the desired purpose, but the coupling transformed the four wheels into drivers and each wheel counted for adhesion. That system has been the modern tendency, until nowadays in America are to be seen as many as ten coupled wheels on a passenger engine.

A "single driving" locomotive may be described as fast, but only suitable for hauling moderately-weighted passenger trains. Single drivers are capable of good work if the weather conditions are not adverse, and the load is fairly light. British weather, however, is proverbially fickle, and it is usually impossible to keep long-distance trains down to about a hundred tons. Consequently even the Great Northern 266 class, with driving wheels of 7 feet 7½ inches, speedily show the disadvantages of the type if the conditions are the least bit unfavourable ; even when the rails are not greasy there is a tendency to slip at starting. One cannot do much railway travelling without knowing what slipping means. An engine wheel, notwithstanding the enormously heavy weight it carries, will revolve at a tremendous rate without making an inch of progress. This very often entails a great strain upon the machinery, even if some portion of it does not break. A second great disability of big-wheeled singles is their small reserve of power, owing to the fact that only a small boiler can be built over big drivers, which, in many cases, have had a diameter of eight and, in fewer instances, ten feet.

In 1836 Campbell of Philadelphia patented an engine with four-coupled wheels and a leading bogie ; and it was so largely adopted in the United States as to become known as the "American" type.

This American locomotive speedily proved popular in England, as meeting the varying conditions of railway working on the average system. Known as the "four-coupled bogie" class, this type presents facility for inside or outside cylinders ; it loses no power through slipping as does the "single" ; it will start straight away with a good load ; and in climbing gradients it loses very little speed.

The varying wheel arrangements in locomotives call for some simple distinguishing classification, unless we desire to give an engine its full title every time we speak of it, *e.g.* a leading bogie four-coupled single-trailing-wheel engine. This is an engine of the "Atlantic" type of which we shall hear much at a later stage. But we write down the type thus, 4–4–2, which denotes that in front there is a bogie with two axles carrying four wheels, four coupled driving wheels, and in the rear a single axle; four bogie wheels in front of six coupled wheels is denoted by 4–6–0; six coupled wheels and two trailing wheels are represented 0–6–2; and all ten wheels coupled by 0–10–0. Goods engines having, as a rule, only coupled wheels present no difficulty in simple designation, but in tank engines, to which we shall presently refer, there is much diversity in wheel arrangement. In their case similar numerical classification will serve with the addition of the letter T underneath.

Of six-wheeled engines we have the six-wheeled single (2–2–2); six-wheeled after coupled (2–4–0); six-wheeled front coupled (0–4–2); six-wheeled coupled (0–6–0). Engines of these classes have rigid wheel bases, for which reason we should not expect to find any of the type in America, where small carrying-wheels in front are the universal rule.

For slow passenger, excursion, fast goods, fish, meat, fruit and milk trains these engines render very useful service. Mr. P. Stirling put over a hundred and fifty of these engines on the Great Northern line alone; while the L.B. & S.C. used locomotives of this type for their best express services; and the L.S.W. uses them a good deal for general work.

Preparatory to comparing the performances of some of the best British locomotives with the best of the American, it will be advisable to touch upon the question of compound locomotives of which the late Mr. F. W. Webb of the L.N.W.R. was for many years a devoted exponent. In Chapter II. we read that by compounding stationary engines we economized steam and fuel with a considerable increase in general efficiency.

It is a fact that compounding up to even quadruple expansion in marine engines has worked wonders for sea transport, and the London and North Western and the North Eastern railway companies hoped to obtain the same good results for locomotives. The North Eastern soon returned to the simple type, but Mr. Webb resolutely held on his way and constructed no less than five classes of three-cylinder compound express engines with driving wheels of from six to seven feet. Slipping was their inherent bugbear, for the high-pressure cylinders exerted power on the rear drivers before the low-pressure cylinders could get to work on those in front; and this defect

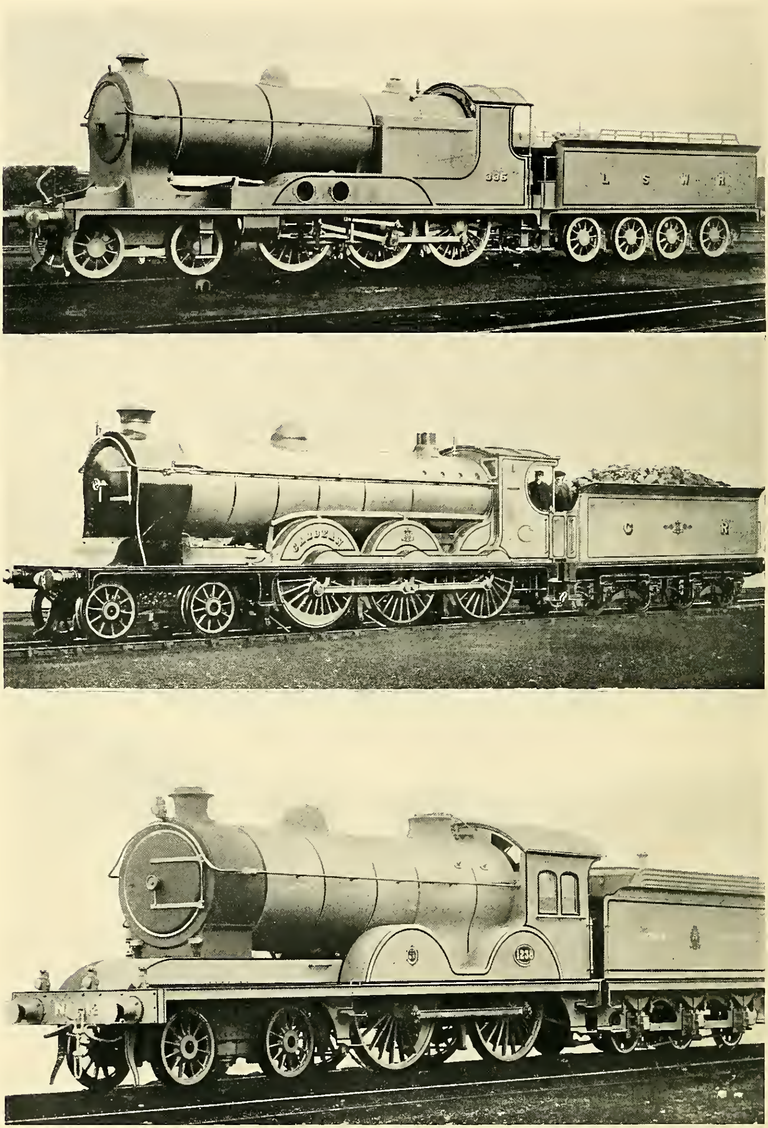


PLATE V.

EXPRESS LOCOMOTIVES.

1. L. & S.W.R. (4-6-0). 2. C.R. (4-6-0). 3. N.E.R. (4-4-0).

alone prevented the type becoming popular on other lines.

In 1895 there was acute competition between the East and West coast routes to Scotland. One August night the East Coast racing train completed the distance from Euston to Aberdeen, 539¾ miles, in 512 minutes, or a shade under 64 miles an hour for the complete journey. The "Teutonic," one of Webb's three-cylinder compounds (2–2–2–0) with 7 feet drivers, hauled the train from Euston to Crewe at over 64 miles an hour. At this time, be it noted, the single driver was the recognized British type for speed, while in America four-coupled engines were relied upon for express traffic.

The West Coast record very naturally put the Americans upon their mettle, and only a few weeks later they accomplished 436 miles at 64¼ miles per hour. But in the United States they pride themselves upon doing things upon a big scale, and they would not rest content until a run was arranged as long as the West Coast, and shortly they selected 510 miles of track upon which to put American engines to a further test. The train weighed 136 tons behind the tender instead of 80 tons as in the British trial. From Chicago to Erie, 424 miles, the rate was just over 63 miles an hour. There yet remained 86 miles before Buffalo Creek was reached, and for this last stretch was utilized a goods-engine with a leading bogie and six coupled wheels of 5 feet 8 inches diameter. In England the small wheels would have been deemed fatal, but this engine completed the journey in less than 71 minutes, at an average speed of nearly 73 miles an hour—at some parts of the journey it reached 93 miles an hour—and raised the average for the whole 510 miles to 65 miles an hour.

Belief in big wheels was promptly shattered, and henceforward there was to be no cramping of the boiler for the sake of huge drivers. Six-coupled ten-wheeled engines became an increasing vogue, of which the L. & S.-Western No. 335 (Plate V), a four-cylinder simple, is a capital example. Its driving wheels are 6 feet 1 inch and its total heating capacity 2798 square feet.

But another notable type of locomotive was in the making, and again its birthplace was America, this time upon the Atlantic City railway. Atlantic City is to New York as Brighton is to London. Our expresses on the London Brighton and South Coast line take sixty minutes for the journey of 50½ miles. With a weight of 300 tons behind the tender the 55½ miles on the Atlantic City line were accomplished in 50 minutes, or 66 miles an hour, and upon special occasions the time was 47½ minutes, or 85½ miles an hour. The engines that performed this feat had two pairs of driving-wheels in front of the fire-box, occupying about the centre of the engine's length, with two wheels carrying the front and two trailing, or in some cases four-bogie wheels in front. This wheel arrangement became known as the "Atlantic" type.

Mr. H. A. Ivatt, of the Great Northern Railway, who succeeded the late Mr. P. Stirling, in 1895 built his famous No. 990. This was the first real "Atlantic" front-coupled ten-wheeled engine in the British Isles. Great Northern expresses, it may be said, render a very good account of themselves: non-stop runs from King's Cross to Wakefield, 175½ miles in 198 minutes; from King's Cross to York, 188¼ miles in 3 hours 35 minutes, at about 52½ miles, are capital everyday performances; while there are several trains daily between London and Peterborough that run the 76 miles at a rate exceeding 55 miles an hour.

For the Lancashire and Yorkshire line Mr. J. Aspinall built huge engines for crossing the steep gradients over the Pennines. The heating surface of his boilers was 2052 square feet, which held our record in this respect for some years. In quite a short time he placed a score of these engines on the road, and up to that time they were the most powerful in the Eastern Hemisphere. But in the Great Northern No. 251, Mr. Ivatt surpassed this heating surface by nearly 500 square feet.

The fastest non-stop booked run in the British Empire, known to the writer, is accomplished by the North Eastern expresses between Darlington and York, the 44½ miles occupying just 43 minutes, or a rate of 61½ miles an hour. Another very fine performance is the journey from King's Cross to Perth, 445 miles in 9 hours 51 minutes, or about 45 miles an hour for the whole of the long distance.

Meanwhile Mr. Webb resigned, and Mr. G. Whale, his successor at Crewe, promptly abandoned compound-cylindered engines, which he replaced by simple expresses, of which the "Precursor" (4–4–0) and "Experiment" (4–6–0) are leading examples. The latter must not be confounded with Mr. Webb's "Experiment," which differed from the "Teutonic" only in having its single drivers 6 inches less in diameter. The "Teutonic" and its sister, "Experiment," disappeared some years ago.

The "Precursor" type bears favourable comparison with any class of locomotives in the country, and by the end of 1906 Mr. Whale had no less than a hundred of them on the road.

It should be noted, however, that though the compound locomotive has gone out of use on British lines, and is not in favour with British engineers abroad, it is quite commonly used by American and continental engineers. Mr. Webb indulged in three-cylindered compounds, whereas the foreign tendency is to go in for four.

"Good wine needs no bush," and London and

North Western time-tables proclaim the excellence of the company's expresses. Euston to Birmingham, 113 miles non-stop in 2 hours (Plate XII); Euston to Manchester, 183½ miles in 3½ hours; Stafford to London, 133½ miles in 135½ minutes; and Willesden to Coventry, 88½ miles in 88½ minutes, are examples that will serve for the moment.

It must not be supposed that we have by any means exhausted the numerous variations in type to be found among passenger engines, but we have traced the growth of the locomotive from the "single driver" to the "four-coupled," followed by the "Atlantic" and the ten-wheeled engine. Of the "Pacific" type something may be said when we deal with America more specifically.

One point must not escape us. Modern travelling is much quicker than of old; it is infinitely more reliable; there are a hundred and one comforts for modern travellers; but there is, after all, no marvellous increase in the maximum speed of which locomotives are capable.

In 1839 the Great Western engine, "The North Star" (Plate XVI), achieved 39 miles an hour, the best authenticated speed up to that date. In the year 1845 a gentleman left Sunderland at 5 o'clock in the evening for London, 261 miles, where he stayed for two hours before setting out on his return, arriving at Sunderland at 10 o'clock next morning, after an absence of 17 hours. If one wish to emulate this feat nowadays by utilizing the booked trains, we might not fare much better. Leaving Sunderland by the 4.25 evening train, we reach London at 10.45. We could return by the 11.30 from King's Cross and arrive in Sunderland at 5.58 next morning. If a stay of 45 minutes in London was insufficient for our purpose, we should have to wait for the 3.15 a.m. train, and should not reach Sunderland until 10.20. But in 1845 the gentleman had what was practically a special train both ways, so that our comparison is not a very fair one.

In the same year the Great Western "Ixion" travelled 62 miles an hour with 76½ tons, and trains belonging to the same company ran from London to Exeter in 4½ hours, reduced the next year to 3 hours 8 minutes. Nowadays it is done in exactly 3 hours. The "Lord of the Isles" was another of this company's engines, which could draw 120 tons at 60 miles an hour. It was shown at the Great Exhibition in 1851. Eventually the "Lord of the Isles" ran 800,000 miles without being renewed.

In 1853, on the Exeter to Bristol broad gauge line, a 10-wheeled tank engine, with 9 feet single drivers, accomplished 81 miles an hour, which until recently was the quickest verified speed; and five years later 70-minute expresses were running from London to Brighton.

But though some of these older engines were capable of fine bursts of speed, they were not as reliable as those of to-day, and they were not called upon to haul such tremendous loads. The travelling public would soon complain if the London and North Western Euston-to-Birmingham express did the journey one day at 81 miles an hour and the next at 70 miles; and perhaps for other days in the week would not accomplish an average of 45 miles. Far better 56½ miles an hour not only for each day in the week, but throughout the year, which is a performance that no locomotives of the 'fifties could be relied upon to do.

Goods Engines

(Plate VI)

We must now pass on to those locomotives that are built specially to engage in goods and mineral traffic. The hardest work that a locomotive is called upon to do is to start its train from a rest. Any boy cyclist knows how much more exertion is required in making a start, when mounted upon the machine at rest, compared to the strength that is required for pedalling when once the bicycle is in movement. A train, too, does not always start on a level; it may have a slope against it at the very commencement.

Power is the main requirement of a goods locomotive, and by coupling all the wheels together every wheel becomes a driver, the cylinders communicate power to all the wheels at once, and in addition the engine gets a better grip of the rails.

The fast passenger trains, no matter how big the engine, always feel the strain of starting, so that we can guess the power that is required to set in motion a dead-weight of sometimes as much as 780 tons. This tremendous weight is hauled by the Hull and Barnsley's goods engines (0–8–0) from Cudworth to Hull. The start is on an incline of 1 in 300, and elsewhere in the journey it is 1 in 150 for 7 miles. On the return these powerful engines will draw 65 empties up a five-mile incline of 1 in 100 without assistance. In the early days of railways many trains had to be helped up inclines, at the top of which stationary engines were placed in order to haul the train by means of a long cable.

The distinguishing feature of the goods engine rests in the coupled wheels. The main types are six wheels coupled for fast goods; and less frequently six coupled wheels with a two or four-wheeled leading bogie; eight wheels coupled; and eight coupled with a single leading axle in front for very heavy mineral trains. The wheels of these three types vary in diameter from 3 feet 6 inches only to 5 feet 2½ inches.

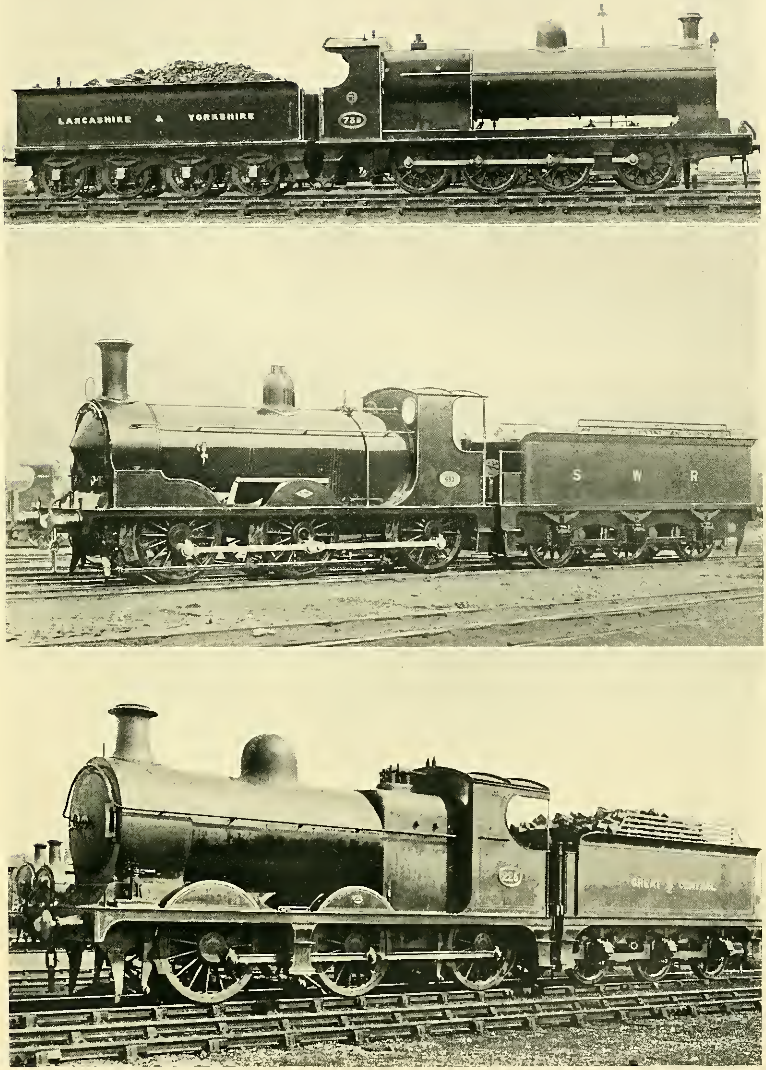


PLATE VI.

GOODS LOCOMOTIVES.

1. L. & Y.R. (0-8-0). 2. L. & S.W.R. (0-6-0). 3. G.C.R. (0-6-0).

Many so-called goods engines are also largely used for heavy excursion traffic; and it may be mentioned that not a few of our best goods engines are but old passenger "fliers," rebuilt to do duty in a humbler capacity.

As with passenger locomotives, so the goods engines show many variations in their general appearance, but when we come to the wheels, the engineers of all countries aim at making the whole weight of the engine available for adhesion, and with comparatively small driving-wheels to gain the highest degree of tractive effort.

Tank Engines

(Plate VII)

A tank engine can be recognized at a glance —it possesses no tender, but carries its fuel and water upon its own framing. Two points at once strike the observer; the tank engine is badly equipped for a long journey and would be incapable of a non-stop run of any considerable distance; but, having no tender, there is no need to turn the engine round at the end of a trip.

This will be an opportune time to note how a big passenger express, or an eight-coupled goods engine, turns round at a terminus in readiness for the return journey. The engine runs on to a turn-table, a circular, revolving, and railed platform, which is sometimes turned by a horse, until the platform rails in front of the engine are in line with the rails in the direction in which the locomotive is now to proceed.

Tank engines are particularly useful for local and suburban traffic; and, in fact, without them it would practically be impossible to run scores of trains in rapid succession into any London terminus between 8 and 10 o'clock in the morning and between 5 and 7 o'clock in the evening, at which time many thousands of workers are proceeding to the city or leaving it.

Tank engines are sometimes used for comparatively long journeys, but not non-stops. A newspaper and mail train leaves Paddington at 5.30 a.m., and arrives at Bristol at 8.25, calling at five stations. It is a $\frac{4-4-2}{T}$ with 6 feet 8 inches driving-wheels.

Much might be said of the development of the tank engine if space would allow, but it would be at the expense of other matters that must not be omitted; and a tank engine after all is only an ordinary locomotive minus its tender. If one will only keep one's eyes open during a railway journey it will not be difficult to discover the chief types.

The position of the water tank is subject to

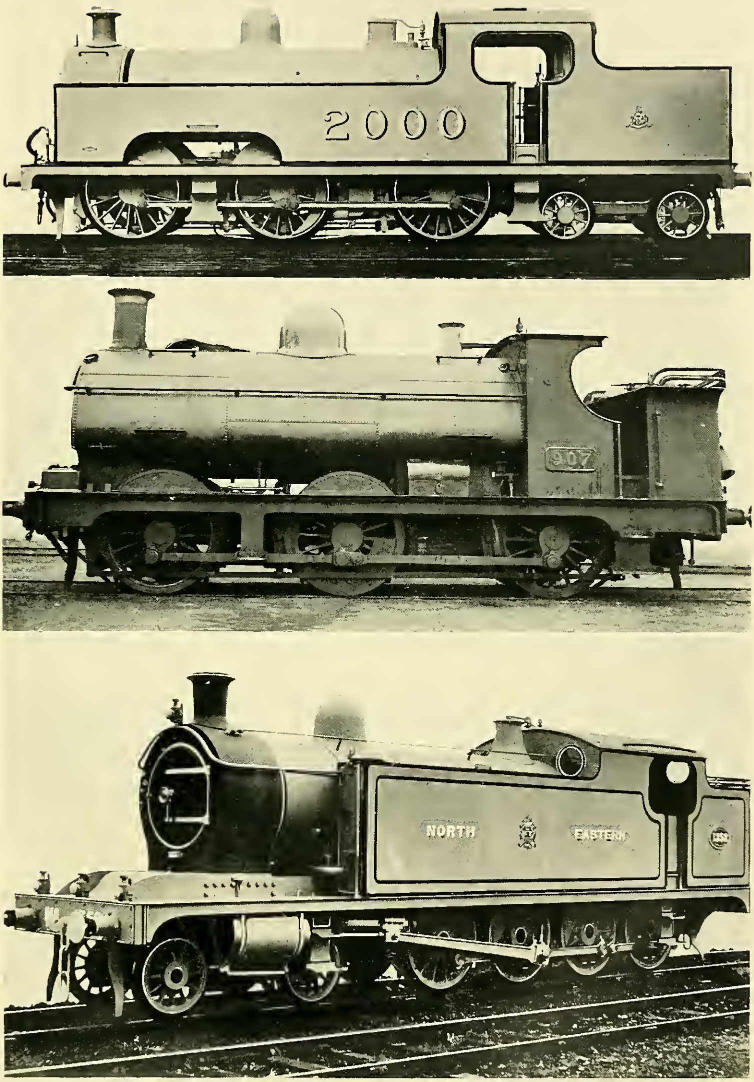


PLATE VII.

TANK LOCOMOTIVES.

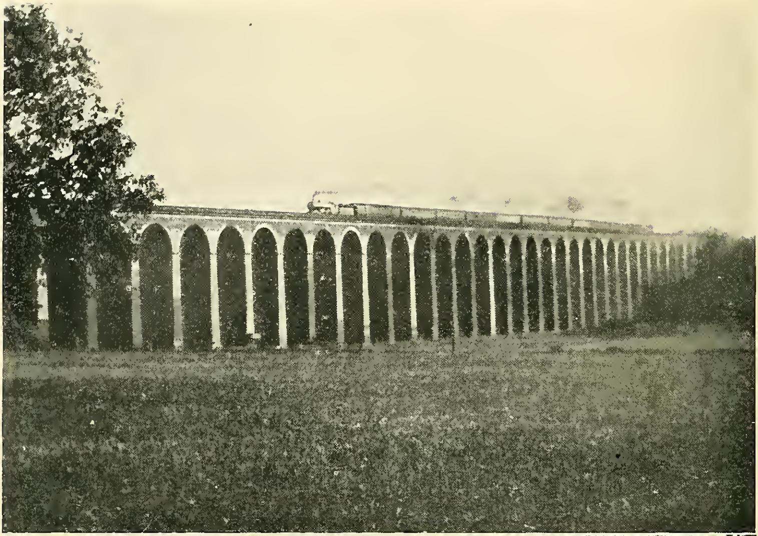
1. M.R. (0-6-4). 2. G.W.R. (0-6-0). 3. N.E.R. (4-8-0).

considerable variation. There are side-tank engines, well-tank and saddle-tank. In the first the water tanks are placed at the sides of the boilers, rising from the frame plates over the driving wheels; in the second the water is stored in a well underneath the foot-plate; and the saddle-tank rests upon the barrel of the boiler in much the same manner that a saddle is placed upon a horse.

Omitting those engines of special design to meet some particular requirements of the line upon which they work, we find that the tank engine largely resolves itself into three main types, viz. (1) After coupled; (2) Front coupled; (3) Six coupled. Having said so much we must leave the illustrations to make the matter perfectly clear.

We will close the chapter with a reference to a tank engine of very special design. The Great Eastern line has to deal with an enormous suburban passenger traffic entering into Liverpool Street terminus. It was suggested that the line be electrified, but the expense of conversion was too great. In an attempt to solve the difficulty, Mr. J. Holden produced his "Decapod" tank engine. He increased the girth of the boiler, put in a larger fire-box, and added to the steam pressure. So much for the engine. He widened his coaches so that they would seat six instead of five aside, added a couple of coaches to each load, and thus with fewer trains was able to deal with the passengers during the busiest periods of the day. This particular engine, however, has been converted into a goods engine (0–8–0), as its weight was too great a strain upon some of the suburban bridges.

In another direction the Great Eastern have tried an experiment of unusual interest, viz. oil fuel engines. In some parts of the world, notably the Baku region of Russia, and Burma, where petroleum is abundant and coal either scarce or entirely absent, locomotives consume petroleum, which is sprayed into the fire-box. Now the Great Eastern is not in easy communication with any of our coalfields, and hence it was that the company decided to utilize some of the waste oil products that are left from the manufacture of oil gas, which was used by the Great Eastern for train lighting. The experiment was a success, and doubtless the Great Eastern at least would have gone in largely for liquid fuel. It was not to be, however, for the rapid increase in motor-cars sent up the price of suitable oil and made liquid firing more expensive than coal.



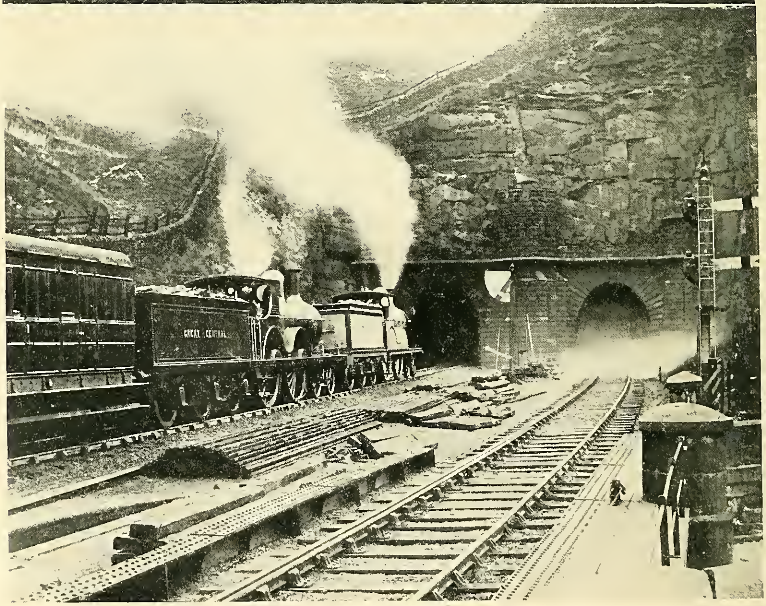


PLATE VIII.

1. WELWYN VIADUCT. 2. WOODHEAD TUNNEL.

CHAPTER VI

HOW A RAILWAY IS WORKED

PART I

IN the construction of a railway the exact route is only decided after the most careful surveying of the country that the line is meant to serve. The surveyors seek for level tracts or the easiest gradients that the configuration of the land will allow. Embankments or viaducts have to be thrown across valleys, rivers and roads have to be bridged, and hills must be pierced, and as these works always cost a great deal of money they are avoided wherever possible. For example, where a river is winding, perhaps a curve will save the necessity of a second bridge, but very often it is essential to bridge the same stream at several different points.

Tunnelling is even more expensive, for the engineers often miscalculate the character of the ground that has to be pierced. Kilsby Tunnel was estimated to cost £99,000, but it ran into £300,000 before it was completed. Box Tunnel is less than two miles long, but it occupied two years and a half in constructing; a ton of gunpowder was used in blasting every week; and from start to finish about 125 tons of candles were burnt in lighting up the excavations and the subsequent lining with brickwork, which called for 30,000,000 bricks. The number of men employed was always over a thousand, and of horses a quarter as many. The Summit Tunnel on the Manchester, Sheffield, and Lincolnshire line, which now forms part of the Great Central, is only about one and a quarter miles longer, but its completion occupied six years. Sometimes 1500 men were employed; the blasting operations were enormous; and during the work about 8,000,000 tons of water had to be pumped out of the excavations. There are a dozen tunnels in this country longer than the Box, and there are thirty others that exceed a mile in length. Woodhead Tunnel (Plate VIII) on the Great Central Railway is over three miles long, and penetrates the Pennine Range about twenty miles south of Manchester.

Smardale Viaduct on the Midland line carries the rails 116 feet above the stream at the foot of the stonework, which necessitated the use of 60,000 tons of stone; and there are many such constructions up and down the country, of which Welwyn Viaduct (Plate VIII) is a capital example.

Between Brentwood and Colchester, on the

Great Eastern Railway, there are sixty-four bridges and viaducts in a length of thirty-four miles; and in the thirty miles between Liverpool and Manchester are more than sixty bridges under or across the metals. The Britannia Tubular Bridge over Menai Strait cost £235,000 (Plate IX); and there are many others that cost very little less, and some a great deal more.

On the East Coast route to Scotland, three bridges which account for less than three miles of track cost £1,310,000, or £498,000 per mile, to which later on is added the Forth Bridge (Plate IX), costing something near £5,000,000, which was shared by four railway companies.

When the Stockton to Darlington railway was commenced, Edward Pease told George Stephenson that it was for a great public way "and its construction must be solid"—and solidity has been the British railway engineers' watchword from that time forward. The very fact that many famous bridges, viaducts, and tunnels date from the early years of the reign of Queen Victoria is proof of it; but there may be mentioned one regrettable exception. The Tay Bridge was only opened to railway traffic in 1878. It cost £300,000, but it was faulty. On the last Sunday night in the next year the centre spans gave way; a mail train which was crossing at the time was precipitated into the estuary; seventy-four passengers perished; and the bridge had to be rebuilt at a cost of £700,000.

The railway track is prepared by the navvies, who were at one time called "navigators," because their chief work had been in the construction of canals. In modern days much of the digging is done by the "steam navvy," a huge shovel worked by an engine and crane, and two or three scoops will fill a big waggon. A whole chapter might be devoted to the work of the navvy alone, but we must hasten on to the laying of the rails.

George Stephenson's first railroad was primarily for the conveyance of coal; and hence he laid his rails, 4 feet 8½ inches apart, so that they would coincide with the tramways in use at the collieries; and this was the width of the rails on most of the lines that speedily followed the opening of the Liverpool and Manchester railway. A perfect mania for railways had set in, and, in the year 1846 alone, Parliament gave permission for the construction of 272 new lines.

When the track has been levelled the rails are laid. First come the sleepers, blocks of wood, 9 feet long, 10 inches wide, and 5 inches deep, which are laid down at regular intervals at right angles to the rails. The earliest sleepers were blocks of stone, and, like them, the first wooden sleepers were laid longitudinally. Upon the wooden blocks are bolted metal chairs with grooves in which the rails

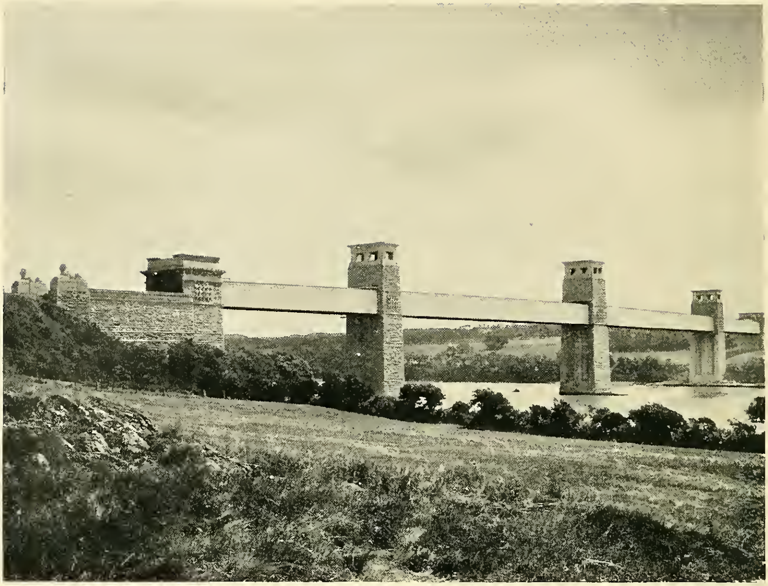


PLATE IX.

1. BRITANNIA TUBULAR BRIDGE. 2. FORTH BRIDGE.

are laid. The present rails are of steel, 60 feet long and weighing from 75 to 100 lbs. per yard, according to the nature of the traffic they will have to carry. Each rail is wedged into the chairs, and the ends of the metals are held together by fish-plates, which are bolted into the rails.

The ends of the rails do not quite meet each other; allowance must be made for expansion during the heat of summer. In a hot July and August the rails between London and Manchester are actually five hundred feet longer than they are in January. This does not mean that the line is any longer, but that the spaces between the rails have been filled up to the extent of five hundred feet.

Even when the rails are in their place we have by no means completed our task, for there are stations and scores of other kinds of buildings to be erected, and the signalling apparatus has to be installed from end to end of the line, together with numerous other matters that there is no space to mention.

It will simplify matters exceedingly if we will take a specially selected railway journey, and well use our eyes from the time we take our ticket until we give it up at the journey's end. We will go from London to a little town right in the heart of the country; and, as to get to our destination we shall change twice and travel on three different lines, we shall gain as much experience as possible for our money.

The train is standing at the platform. The driver is examining the fittings in the cab, the fireman is hanging on to the side of the engine, making sure that some important part of the machinery is well oiled, and porters are hurrying with luggage to the guard's van.

First let us examine the steed that is to take us on a non-stop run of 113 miles. The type is 4–4–0, so that we may reasonably expect something in the way of speed. The driver and the fireman took charge of the engine half an hour ago at the "Loco" depôt or engine shed, where they had left it the previous night after an up journey. This morning they found the tender loaded with coal, the water tank full and steam up; for the engine cleaners can get a supply of live fire from the lighting-up furnace, which also dries the sand for the sand-boxes. The engine runs to the carriages, links up, the continuous brake is connected, and then the train is ready to proceed on its journey.

You have seen a brake at work on vehicles drawn by horses, and in all probability you know something about the brakes on a bicycle; in the case of the engine and carriages the brakes are of still greater importance.

An engine is fitted with several steam-brakes that operate on its own wheels, while a hand-brake works upon the wheels of the tender. On every passenger train there has to be a continuous automatic brake, the best known of which are the Automatic Vacuum and Westinghouse Compressed Air Brake. It is difficult to say which is the better; but it is easy to acknowledge that both of them are very good.

In the Vacuum Brake there is a cylinder under each vehicle from end to end of the train, and in each cylinder there is a vacuum on both sides of the piston. To put on the brake the driver admits a little air into the end of the cylinder, and since there is no pressure on the other side, the piston is forced up, with the result that the brake blocks are brought into contact with the wheels. When the driver withdraws the air, the brake is released and again an ejector in the engine keeps up the vacuum.

In the Westinghouse brake the action is very similar, except that it works by compressed air instead of a vacuum. Under each of the vehicles is a reservoir connected by a pipe extending throughout the length of the train, with connections with each of the carriages and the engine tender by means of a flexible pipe. The engine is fitted with a little steam pump, which supplies the reservoirs with air at a pressure of 75 to 80 lbs. per square inch. The driver, by a simple operating handle, cuts off the train pipe from the reservoir, which forces the piston outwards and applies the brake.

We are allowed no further time for examination. It is a corridor train with a passage along one side of each carriage into which open the doors of the several compartments. The carriages are joined to each other by a telescopic bridge, which allows the guard to walk from his van right up to the compartment which is nearest to the tender.

We take our seats and an official puts his head in at the window to examine our tickets. The guard is on the platform looking at his watch ; the porters are closing the doors ; the wooden arm of a signal on a big gantry ahead of us suddenly dips ; the guard whistles or waves a green flag ; the engine blast-pipe belches out steam through the chimney ; and the iron-horse moves away from the platform, getting into its stride before the guard's van has cleared the end of it.

As we leave the station we catch a fleeting glimpse of a big signal-box (Plate X), where men in their shirt sleeves operate scores of bright levers. Every lever that is pulled or released alters a signal, or acts upon the switches of the rails where they cross each other. We can see rows of telegraphic instruments, gongs and telephones.

The whole question of signalling bristles with difficulties in the way of simple explanation. It is easy to understand how a lever acts upon a wire that is connected with a semaphore arm; but in modern signalling there are almost endless automatic and electrical devices that would be hard to understand, even with a liberal use of diagrams; and in many cases a moving train itself works a signal.

On a straight line signalling is comparatively easy, not that it does not call for the exercise of the greatest care; but at entrances to stations, where the lines are many, and at crossings where other lines join up, the difficulties of the signalman are intensified. Suppose just when an express is darting along, a local train failed to clear a crossing. There is no need to explain what would be the consequences. Mechanical ingenuity, however, prevents such a situation. By a system that is known as "interlocking," the main line and the branch cannot be open at the same time. When the lever is pulled to put the signal at "clear" for the express, it works at the same time the interlocking local signal and puts it at "danger." Nevertheless, the signalman carries enormous responsibility upon his shoulders. One muddled moment might mean a great sacrifice of life; but to their credit be it said, British signalmen very rarely know what a muddled moment is; and thus on our lines is to be found the greatest security known to the railway-travelling world.

As the train glides along, we look out of the window. We see signals ahead in our favour, for the news of our coming is telegraphed, or gonged, or, more rarely, telephoned from signal-box to signal-box. The signalman, who has been on the look-out for us, promptly loses all interest in us the moment we pass him, for we are in the next section of line and are already interesting a man in a box that is perhaps not yet in sight.

Shortly some distance ahead of us we perceive a dozen men, "platelayers," at work on the line, putting down fresh ballast, re-wedging the rails in the chairs, or tightening the bolts of the fishplates (Plate XI). We wonder what will happen if they do not notice our approach in time. You may depend upon it that our driver has got an eye upon them, and if they showed no signs of moving out of harm's way the engine whistle would shriek out a warning. But one of the gang is not at work with his hands; it is his business to keep his eyes open in watching for coming trains. He blows a whistle and the platelayers drop their tools and step into the "six foot," or the space between the two sets of metals.

Presently we have rushed through the forest of houses, the buildings become more scattered, and we are out in the open country. A smart young official suddenly presents himself to us to ask whether we wish to take luncheon on the train. The pressure of an electric button in the compartment will summon the dining-car attendant at any time. One of the cars is a well-appointed dining-room with a kitchen, cook, and waiters complete. The Great Eastern Company on a single train has served breakfast to 226 passengers, who sat down to the meal in two relays. For fast trains, that have no dining-car, luncheon baskets are provided for any passenger who will notify the guard. He telegraphs from one station to another, and upon arrival there the basket will be in readiness.

In every compartment of the train, just over each door, there is a metal pipe through which runs a chain, which a break in the pipe exposes to the view. This chain affords a passenger means of communicating with the guard in cases of great emergency. A tug at the chain applies the brake slightly, as it opens a valve in the automatic apparatus, and, the driver at once responding, the train is brought to a standstill. The guard can tell in which carriage the chain was pulled by means of an indicator at the end of the vehicle, and the slackness of the chain points out to him the exact compartment from which the summons came. Unless the passenger can show good cause for his use of the communication chain he renders himself liable to a heavy fine. It would be absolutely inexcusable to stop the train because one's hat has blown off when looking through the window. It would, however, be quite justifiable if a dangerous ruffian had attacked a passenger, or if a person were taken seriously ill and required medical attention at the next station, at which otherwise there would be no stop.

We notice now that our speed has slackened. We have just passed a short post by the side of the line, from which projects at an upward angle a little board upon which was painted 1 in 150. This tells us that we are on a gradient that ascends 1 yard in 150; and the engine cannot keep up the speed that was possible on the level, unless we rid it of a portion of its load. Gradually we mount the incline, and as we pass over its crest we note another gradient board. This time the arm is at a downward angle and the figures are 1 in 300. The slope is only half as much in our favour, as it was recently against us; but in all probability it will be longer, and the time our driver lost during his climb he will be able to make up in his descent.

On and on we rush. Here there are meadows on either side of us, presently we pass through a wood, and a few minutes later we are hurtling across the top of a huge embankment that has been thrown across a wide valley. Then there is a crunching of brakes, and our rate is lessened until it is a mere crawl. Why? We are now on a stretch of moorland apparently miles from everywhere. The driver knows why. Ahead of us is a signal with its arm stretched out at right angles,

PLATE X.

SIGNAL BOX, CANNON STREET STATION.

and until it falls he will not pass it, however long we may be detained. He is crawling in the hope that he will be given " clear " without necessitating an actual stop. Down it goes, and the train commences to gather speed again. A quarter of a mile further on, we can judge quite correctly why the signal was against us. We are passing a branch line, and there is a train that has only recently left the line upon which we are travelling.

The engine is steadily eating up the miles; probably the driver is attempting to make up for the time which we lost, when the signal was against us, for in a race against time every second counts. We can time the speed we are making by means of the quarter-mile posts along the side of the line. Count the seconds which the train takes to pass between any two posts and divide by 900. We find that the time is 15 seconds for 440 yards, which is, of course, exactly at the rate of sixty miles an hour.

In this case we can find the result by the easiest mental calculation. Suppose it had been 18 seconds, then our rate per second would be $\frac{18}{900}$ or $\frac{1}{50}$ of a mile = 50 miles an hour.

Suddenly the fields disappear, we have shot into a deep cutting, the top of which can barely be seen from the carriage windows. We are running between two walls of rock. No steam navvy dug out this road. No; every yard of it had to be blasted, and we have already discussed the expense of such work.

A screech from the engine and we are in darkness. We are rushing through a tunnel, four or five hundred feet below the summit of the hill that was pierced for the iron road. But we have no fear. The engine-driver holds our lives in the hollow of his hand, but he knows his engine as a good rider knows his horse. For years as a boy he cleaned engines, and for still longer years he acted as fireman, travelling hundreds of thousands of miles and shovelling thousands of tons of coal into the fire, before he was allowed to drive even a local tank engine. He must be able to distinguish signals at a glance, and on his present run there are several hundreds for him to watch. He must know the road by day or night—know it so well that in foggy or snowy weather the dimmest outline of the landscape features will tell him where to look for his signals.

While we are thinking about our friend on the footplate, we are out again in the broad daylight. On and on and still on. We pass through town after town, village after village; and at the end of two hours we glide into a big station and our grand steed comes to its first rest since we left London. Please note that this speed is not a special performance for our benefit, just to show of what the engine is capable. It is in accordance with the company's time-table, and the same splendid result is attained day after day throughout the year.

We now have to change, and out on the platform we have time to take in the bustling scene. It is a large station; there are bridges over the platforms and subways underneath them, for it would be sheer madness to attempt to cross the metals, with so many trains constantly moving one way or the other. Bookstalls, refreshment-rooms, waiting-rooms, cloak-rooms, telegraph office, automatic machines of all kinds, and even flower, fruit and sweet stalls are all for the use and convenience of passengers.

Our interest, however, is concerned more with the line itself. Look at those two buffer stops at the dead-end of a set of rails. What tremendous things they are! They are of the very latest hydraulic type. A train of 400 tons weight can run into the station at a fair rate of speed, and be brought to a stand within a few feet without a severe shock.

CHAPTER VII

HOW A RAILWAY IS WORKED

PART II

OUR second train is awaiting us at a neighbouring platform. It is a good-looking train, but not to be compared to the "flier" which brought us to the end of our first stage. The engine is a 0–6–0 of the tank type, and consequently should be capable of a fairly high speed, though we must not expect anything like sixty miles an hour. We notice, too, that the train is composed of ordinary coaches, and having no corridor in which sometimes to take our stand, we are restricted to one compartment and, if it is crowded, to one seat. Our last carriage was heated by steam-pipes from the engine; but this one is but slightly warmed by means of foot-warmers, metal vessels which at present contain hot water, but which, on this December day, will give out decreasing warmth as we proceed on our journey.

We take our seats. The ticket examiner comes to inspect our tickets, and when he learns our destination he directs us to remove into the last carriage, the reason for which we shall learn in due course.

A man is walking along the "six foot" by the side of the train. He carries a double-headed steel hammer, affixed to a long handle. He is giving each carriage wheel a smart tap in order to ascertain that there are no defects in it before the train sets out. The wheels of the express train had been similarly tested before it was brought to the platform, or we should have noticed this operation earlier. One might think it a very careless way of examining a wheel, but you may be sure it is the best that is known to railway men. If the wheel is sound, the hammer rebounds and the metal rings as true as a bell; whereas a crack or other flaw would cause the ring to be dull and there would be no rebound.

We recommence our journey, and in all respects, except speed, it is very similar to the first stage. Although we are no longer on a main line, we see that the railway-builder met with exactly the same difficulties in the construction of the track; there are still gradients, bridges, cuttings, embankments, viaducts and tunnels.

Since we started, the weather has undergone a marked change. It has grown increasingly murky, and presently we run into a fog that blots out all the landscape. From the window we can scarcely see the metals on the up line. Surely we cannot proceed. Electric trams in a well-lighted town would have to cease running in such a white pall, that one almost could cut with a knife. We know that trains travel at night as easily as by day, for the coloured lights of the signals point out the way to anybody who is not colour-blind; and a railway company takes very great care that neither drivers nor signalmen suffer from any such disability.

Our driver is now only going at about quarter speed. Bang! bang! That will prove a welcome sound to the two men on the foot-plate; it shows that the "foggers" are at work. These men, who are usually platelayers, take up a position beyond the distance signals but sufficiently near enough to distinguish the lights or the semaphore arms. The driver's eyes are of little use under the circumstances, and consequently his ears must serve him. The "fogger" not only carries a lamp with which he can display coloured lights, but he places detonators or fog-signals on the rails near to the signal-posts. A detonator is a circular metal case, about twice the diameter of a penny piece, half an inch thick, and containing percussion caps and a small charge of gunpowder. The "fogger" attaches two detonators close together upon a rail as long as the signal is at "danger"; when it changes to "clear" he takes them off again. The detonator is fitted with a clip, by means of which it is easy to fix it or release it. But while the signal is still at "danger" a train comes along; the engine-wheel explodes the fog-signal; and the driver is at once warned that he is close to a signal which is against him. The second detonator was only placed on the rail in case the engine-wheel skidded the first one off and failed to explode it; but if the first one explode, the fogger removes the second one, if possible, and thus saves expense and an unnecessary warning. Fog-signalling is expensive, for the detonators cost 9*d.* a dozen; the L. & N.W.R. uses as many as 12,000 in twelve hours; and fogs in a single year cause some of the companies to expend £10,000 each. Upon this occasion, however, the fog is only troublesome in a low-lying valley, and as we ascend to a higher level we run quite clear of it.

An engine-driver fears an ordinary snow-storm far less than fog. The feathery flakes may blind his look-out windows, so that when he is on the look-out for signals, he has to peer round the edge of the cab in the face of a wind that stings like a whip-lash; but he will tell you that a snow-storm cannot match fog for treachery and danger.

A really heavy fall of snow is in all conscience a very serious matter, especially in exposed districts and in cuttings where deep drifts are formed. The weight of the snow, too, on a long length of wire, has been known to force a signal semaphore down, when the man in the box believed it to be at "danger." At Abbots Ripton on January 21, 1876, an accident was caused in this manner. The Scotch express hurtled past the signal and ran into a coal train. The express was wrecked and engines, carriages and trucks lay across both lines. Worse was to follow! Almost before the uninjured realized what had happened, the Leeds express dashed into the debris to render the scene doubly terrifying. In this case snow caused the deaths of thirteen people, while fifty-three others were injured.

As may be expected the Highland Railway experiences most dislocations from snow; for its lines traverse wild moorlands and skirt the bases of high mountains, where snow quickly gathers to a great depth. In some of the most exposed parts of the line fences are erected, which in moderate snow-falls prevent the formation of deep drifts; but when the fall is heavy drifts do occur, and then there is trouble indeed. The Great North of Scotland and the North Eastern lines also suffer a great deal at such times.

One big block on the Perth section put an end to all traffic for six weeks. Whole train loads of fish and other perishable commodities were ruined, and live-stock in the cattle trucks died for lack of food. One train was dug out of the snow, and a humorous newsman reported that he only

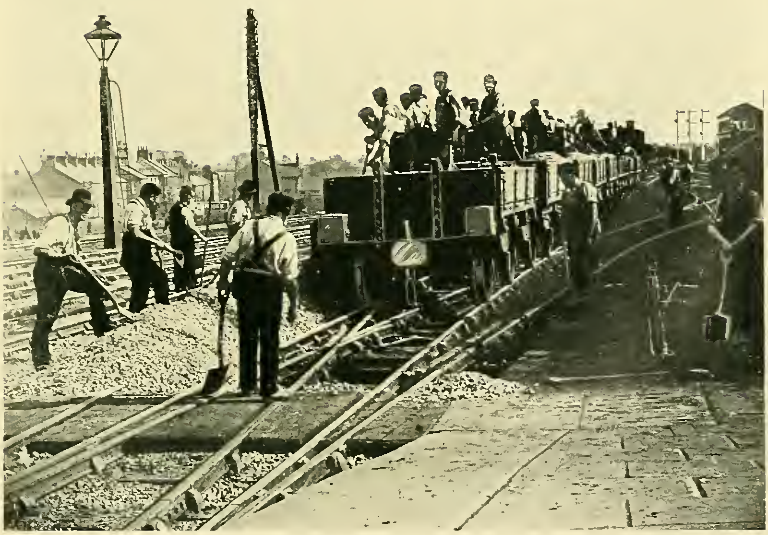


PLATE XI.

1. SNOW PLOUGH, HIGHLAND RAILWAY. 2 PERMANENT-WAY MEN.

discovered a second buried train, when he put his leg down the smoke-stack of the engine.

Snow-drifts are removed by means of a specially-constructed plough, that is sometimes pushed by as many as five locomotives (Plate XI), carrying a staff of, perhaps, fifty men. Between Alnwick and Gateshead a snow party had a most Arctic experience. They cleared the track of snow, fourteen feet deep, for several miles, and then stuck fast in a cutting. They were there for thirty-eight hours without food or drink—and now a snow party takes care to be amply provisioned before setting out on such a task.

It is rather surprising to find that the Great Western Railway, which is mainly a southern line, should suffer severely from snow; but it traverses some very exposed tracts. In a snow-storm, in 1881, on this line there were no less than fifty-one passenger trains and thirteen goods snowed up in Berks. and Wiltshire alone. This one downfall of snow cost the company a round £56,000.

Upon this present occasion we have got rid of the fog and there is no prospect of snow. We are making good progress and presently arrive at a junction. We are not yet going to leave the train, although it is about to travel over another company's metals for some miles. Many of the railway companies run over each other's lines in a manner that would be most confusing to attempt to explain. We took our tickets at a station belonging to one company and we have travelled about 130 miles on its lines; now we are about to pass into another company's territory; and shall complete our journey in that of a third. The money we paid for our tickets is in the London booking office; but you may be quite sure that the companies over whose lines we travel will receive their fair share of our fare.

Just before we leave the junction an official, pencil and notebook in hand, passes along the train, noting down the numbers of the carriages, the classes of vehicle, the engine, and various other particulars. He is a Clearing House number-taker. Whatever the weather, at all hours of the day or night, these officials are gleaning similar particulars concerning both passenger and goods traffic. All this information is forwarded to the Clearing House in London, to which go all the tickets that have been used by passengers upon more than one line. The duty of the Clearing House is to trace the course of the passenger over the various lines and apportion each company's share of the fare; and the same applies to goods traffic. The Clearing House commenced its work in 1842 with a staff of half a dozen clerks; in 1861 the number was 400; and now a staff of about 3000 occupies a great building in the neighbourhood of Euston Station.

All along our route we have constantly met with other trains, up-expresses, slow locals, goods and mineral trains, of which we need say nothing. One train, however, that flashed past us could scarcely fail to attract attention. It consisted of an engine and only one coach—and more than that, it was carrying only one passenger.

A passenger with a train to himself! Yes; and you can have one at any time of the day or night upon any line, if you are only prepared to pay for it. Such a train is called a "special," for which the charge is 5*s*. per mile plus the ordinary fare. "Specials" are only used in very urgent cases. A famous doctor may be summoned to a patient who is in a critical state; and it may entail a long journey, for which there is no booked train until it would be too late. Sometimes a dying person has engaged a "special," simply that he or she might die amid the dear familiar surroundings of home. At other times business men, anxious at very short notice to catch an out-going vessel, have recourse to a "special," for which the fare from Euston to Liverpool is about £50.

We have but to go eight miles before we change on to another line. Presently we look out of the window. Oh! our coach has broken away from the train which is forging ahead of us, although the carriage is following at a good rate by its own momentum. There is no need for alarm. We are in a "slip" coach, the coupling hook of which works by means of a hinge and a pin. The withdrawal of the pin releases the hinge and frees the coach from the train, which to save time does not stop at the station at which we wish to alight. The slip coach has a guard of its own, and by means of the automatic brake he draws us up at the platform, while the train is just disappearing in the distance.

This station is very different from any at which we have previously stopped. It is a country station, and all the houses within sight would not make a good-sized village. On a siding is a rather small tank engine, to which are attached only two passenger coaches, several coal waggons, a couple of cattle trucks and a guard's van. Presently this miscellaneous assemblage of vehicles is drawn up to the platform, and we learn that the last stage of our journey is to be accomplished by means of what is known as a "mixed" train, that is, passengers and goods combined, if you can call coal, and cans and sheep, "goods."

We are not yet due out, for there are a score of milk cans to be placed in the guard's van. We look at the labels and find that they are "empties" from London. Surely Londoners can obtain their milk much nearer home. The average distance that milk travels to any great city is about a hundred miles; but the Great Western, for example, takes 27,000 gallons a year from St. Erth to London, and that is a distance of 320 miles, for which the railway charge is $1\frac{1}{2}d.$ per gallon; and the L. & N.W.R. carries milk from Monaghan, which is 410 miles.

When at length we do start, there is an entire absence of bustle that we noticed at the greater stations. We have got into the backwoods of the railway world. Whatever our engine is capable of doing, we are only booked for twelve miles an hour. A rustic train of this kind gives the local wits many opportunities of poking fun at its shortcomings. A fellow-passenger informs us that the driver has been known to draw up in order to gather mushrooms in a neighbouring field, and that a dog fight would certainly cause him hurriedly to put on his brakes. But we happen to know better. The speed is probably sufficient to serve the needs of the district, and anything faster would probably only damage the light rails, which are considerably less than the 100 lbs. to the yard rails, which are necessary for fast and heavy traffic.

In a little over half an hour we are at our journey's end, and we step on to the platform of the small market-town, just 144 miles from London, to which we have been carried along the gleaming metals for just as many pence.

Since we set out we have seen railway men of many ranks—station-masters, inspectors, booking clerks, ticket examiners, permanent-waymen of various grades, signalmen, gate-keepers at level crossings, in addition to the men on our own train; but there is a host of servants with whom a passenger does not necessarily come in contact. In the service of a big railway company there are, perhaps, as many as eight hundred different classes of employment. We shall learn something more concerning these, when we come to read more in detail the doings of some of our best-known lines, upon many of which the employés number from 50,000 to 80,000.

CHAPTER VIII

A GARLAND OF IRON RIBBONS

Part I

A GLANCE at a railway map of the British Isles will tell what suggested the title of this chapter. Ribbons, indeed, and as puzzling a bunch of them as it is possible to find, for they are crossed, interlaced and knotted together to such a degree that it would appear well-nigh impossible to tell to whom some of the smaller loops and streamers really belong.

Between Land's End and John o' Groat's and in Ireland there are over 23,000 miles of iron road owned by about 250 companies. We pause for a moment. Did we not read that during the "Railway Mania" in 1846, Parliament sanctioned the construction of 272 lines? Since that date hundreds more must have been constructed. What has become of them? In its time the Great Western alone has swallowed up about two hundred small lines, and other companies have followed suit; many of the smaller remaining lines are leased or worked by the greater ones; and for practical purposes we may say that about 25 companies have their hands on our garland of iron ribbons.

In any case there are only five companies with more than a thousand miles of lines each, while there are thirty with less than a hundred. The Easingwold Company in the North Riding possesses only 2½ miles of line with one locomotive and two passenger carriages. If some dark night one of our great companies lost 2½ miles of line, it would be missed in the morning, probably earlier; but it is very certain that one engine and a couple of carriages might go astray and almost escape attention until the annual stock-taking.

Our British railway lines, all told, cost not a penny less than £1,000,000,000. Dealing only in round figures, of our twenty-three thousand miles of line, more than a half is double-tracked or more; quite a thousand miles have three or four sets of metals, and some shorter stretches of line have six or seven. Upon the network of rails ply three-quarters of a million vehicles, of which some 20,000 are locomotives, which each average about 18,000 miles a year.

In a year the British locomotives travel not less than 400,000,000 miles, or about fifty trains a day over each mile of line. Every twenty-four hours are carried more people than there are in Paris, together with about 13,000,000 tons of goods

PLATE XII.

LONDON TO BIRMINGHAM, L. & N.W.R. "POLYPHEMUS."

and minerals. The total income of the railway companies for twelve months may be set down at £120,000,000, of which over 40 per cent. comes from the passenger traffic.

The goods departments of all the lines usually carry about 100,000,000 tons of general merchandise and 380,000,000 tons of minerals, an enormous business that is less in evidence than the passenger traffic, because a very great proportion of it is carried during the night, when the rails are largely freed from passenger trains.

We will now proceed to a consideration of four typical English railroads, each in its own way prominent in the railway world. If we then conclude with brief comments upon some of the remaining lines we ought to have gained a good working idea of the British railways as a whole.

London and North-Western Railway

The L. & N.W.R. was not born, but like Topsy in "Uncle Tom's Cabin," it "just growed." Robert Stephenson was appointed engineer of the suggested London to Birmingham line. The surveying of the route was one long struggle against the opponents of the project. Stephenson and his party, in some places, could only carry out their inspection by means of dark lanterns at night; clergymen denounced them from the pulpit; magistrates threatened them from the bench; and often they were driven out of fields at the points of pitchforks. Robert Stephenson tramped the entire route a score of times until his plans were completed; and after various delays Parliament gave permission to proceed.

On July 20, 1837, just a month after Queen Victoria succeeded to the throne, the new line, the first from London, was opened as far as Boxmoor; and an account of the primitive arrangements then in practice will afford equal interest and amusement.

A first-class compartment contained six numbered seats; second-class accommodated eight passengers, but the seats were not upholstered; and a third-class was roughly seated but possessed no roof. Each passenger received a paper ticket torn from a book, and his or her name was written upon the counterfoil. Endeavour to imagine what would happen nowadays if a company reverted to such a system. Picture tens of thousands of football enthusiasts booking at Victoria Station for the Crystal Palace on the day of the final tie in the English Cup football competition. Even with the expeditious arrangements of to-day the task of the booking clerks is herculean; but the old system would lead to a chaos that no pen could describe.

Elsewhere mention has been made of the

arduous labour and expense of constructing Kilsby Tunnel, five miles south of Rugby; but eventually the line was completed to Birmingham, and the whole length formally opened in September, 1838.

Even then the troubles of the promoters were not at an end. The stone blocks used for sleepers proved to be a failure; signalling by means of flags in the daytime and hand-lamps at night was ineffective; and the passengers' luggage, which was carried on the tops of the carriages, frequently took fire from the engine sparks, for Stephenson's locomotives were not fitted with "spark arresters."

The third-class passengers suffered much tribulation. They were subject to every wind that blew; when it rained or snowed they had the satisfaction of knowing that there was less fear of their clothes catching fire; but at all times the hot cinders from the smoke stack were a menace. It is said that some of the passengers used to make bets with each other as to whose eyes would hold the most cinders.

In the year 1846 the London to Birmingham, the Manchester to Birmingham, and the Grand Junction lines amalgamated to form the London and North-Western Company. With lines of a total length of 420 miles and 257 locomotives the new Company was the largest in the Kingdom; it was forthwith Britain's chief line, as it is to-day, and, in fact, the leading railway of the world.

Suppose we now take a bird's-eye view of the system, remarking upon notable events and performances in its history until we reach the present day.

First, concerning some of the more interesting engineering works upon the line. The massive archway at the entrance to Euston Station is certainly one of the wonders of the railway world; and if the station is the oldest, it remains among the largest in London. The Britannia Tubular Bridge connecting the Island of Anglesey with Wales has already been mentioned, but Runcorn Bridge over the Mersey is a very imposing structure. Kilsby Tunnel (page 81) is exceeded in length by one from Edge Hill to Liverpool (3558 yards), three parallel tunnels at Standedge in Yorkshire (5340 yards), while in North Wales the Festiniog Tunnel was bored through 3726 yards of solid rock. Water troughs for the fast express services are found on no less than fourteen stretches of line in different parts of the country. Of the severest gradients mention must be made of the celebrated Shap incline, the summit of which is the highest point on the L. & N.W. metals. On the Cromford and Hay mineral line are two steep inclines, up which the trains are hauled by stationary engines.

Of the 2000 miles of line comprised in the system, more than 1700 miles are the Company's own property. From London to Crewe is 158 miles, with branches on the right to Cambridge and Peterborough, and on the left to Oxford, Birmingham and Shrewsbury. From Crewe we get several magnificent runs, *e.g.* straight ahead to Carlisle; on the right to Leeds or Manchester; and on the left to Liverpool or Holyhead. All these widely separated towns, and many scores of others between them, are reached without traversing a single mile of line belonging to another company.

The longest run without a stop is from London to Liverpool, 193 miles in 3 hours 28 minutes. There are numerous short routes and quick services to many important towns. On what is known as the Royal Mail Route we get from London to Manchester, 184 miles in 3½ hours; Carlisle, 299 miles in 5 hours 50 minutes; and Chester, 179 miles in 3 hours 40 minutes. We can reach Holyhead in 5 hours 15 minutes, from whence the company's own steamers will convey us to Dublin in another 3¾ hours. Euston to Birmingham, 113 miles in two hours, is another excellent service (Plate XII).

On page 52 we discussed the "dry steam pipe" and the question of dry steam being capable of better work than saturated steam; and brief reference was made to the "superheater," a modern contrivance which rids steam of its moisture or saturation. In the last few years the superheater has come into ever-increasing prominence. Locomotive builders found that by its means they obtained the greater steam-power which they required, without enlarging the boiler or increasing the heating surface; and were thus enabled to use larger cylinders, producing an increase of speed and greater hauling-power with a diminished consumption of coal.

Mr. George Hughes, of the Lancashire & Yorkshire Railway, was the first to test the superheater on British goods engines; the London, Brighton & South Coast Railway tried the apparatus on tank engines; the Great Northern experimented with an Atlantic express engine; and the London & North Western and the Great Western Companies also gave the superheater a trial.

Just as this matter goes to press it is announced that the locomotive department of the London & North Western Railway has decided to add to its stock of powerful express hauling engines, by building a large number in which superheated steam is the outstanding feature. Twenty superheated engines and another score, similar in every way except that they will be without the superheating apparatus, are being built in order to test their efficiency and to determine the relative cost of construction and maintenance of the new type and the old.

Trials of the first engine of the new type, named George the Fifth, have been in every way satisfactory. With a heavy load of 340 tons it ran the 158 miles from Euston to Crewe in 159½ minutes, not allowing for "slacks." On another spin to Holyhead the engine attained for some distance eighty miles an hour.

On page 69 was described the famous West Coast run to Aberdeen. This, of course, was merely a race against time, for which all traffic on the lines concerned had to give place. Ordinarily the quickest run to Aberdeen is 11 hours 28 minutes for the 540 miles. Glasgow (401 miles) is reached in 8 hours 15 minutes; Edinburgh (400 miles) in the same time; and Inverness (568 miles) in 13½ hours.

These latter runs are only possible by combination with the Caledonian Railway, for which the two companies use joint-rolling stock, which bears the letters W.C.J.S., meaning West Coast Joint Stock.

On all the chief railways most of the long-distance trains carry a dining car, in which the passengers can sit down to a hot meal as comfortably as though in a first-class hotel restaurant.

For night journeys on long runs sleeping apartments are provided for those passengers who are prepared to pay for the luxury. Sleeping cars were first used on the West Coast route on October 1, 1873, and ten years later corridor sleeping saloons were introduced. It is possible for a passenger to travel from London to Glasgow by the train leaving Euston at 11.50 p.m.; he can at once retire to bed and wake up at 8.5 next morning to find himself at his journey's end. Travelling by the East Coast route, which is $42\frac{1}{2}$ miles longer, he would leave King's Cross 20 minutes earlier and arrive at Glasgow an hour later. The Midland route, viâ Settle and Carlisle, is two hours longer than by L. & N.Western; and the journey on the Great Central line occupies eleven hours.

In travelling from London to Edinburgh the East Coast route is more advantageous by 15 minutes, the route being 5 miles shorter than by L. & N.Western viâ Carlisle; but the Midland and Great Central each occupy nearly $1\frac{1}{2}$ hours longer than viâ the Great Northern, North-Eastern, and the North British lines.

In Chapter V., L. & N.W. locomotives played a worthy part upon many occasions. Three events in the company's locomotive history must not be omitted. On June 16, 1900, at Crewe works was completed the 4000th engine, "La France," which was exhibited at the Paris Exhibition. To mark this notable achievement the Directors granted their 8000 employés at their locomotive works a day's holiday without loss of pay; while upon Mr. Webb, the Chief Mechanical Engineer, was conferred the freedom of the borough of Crewe.

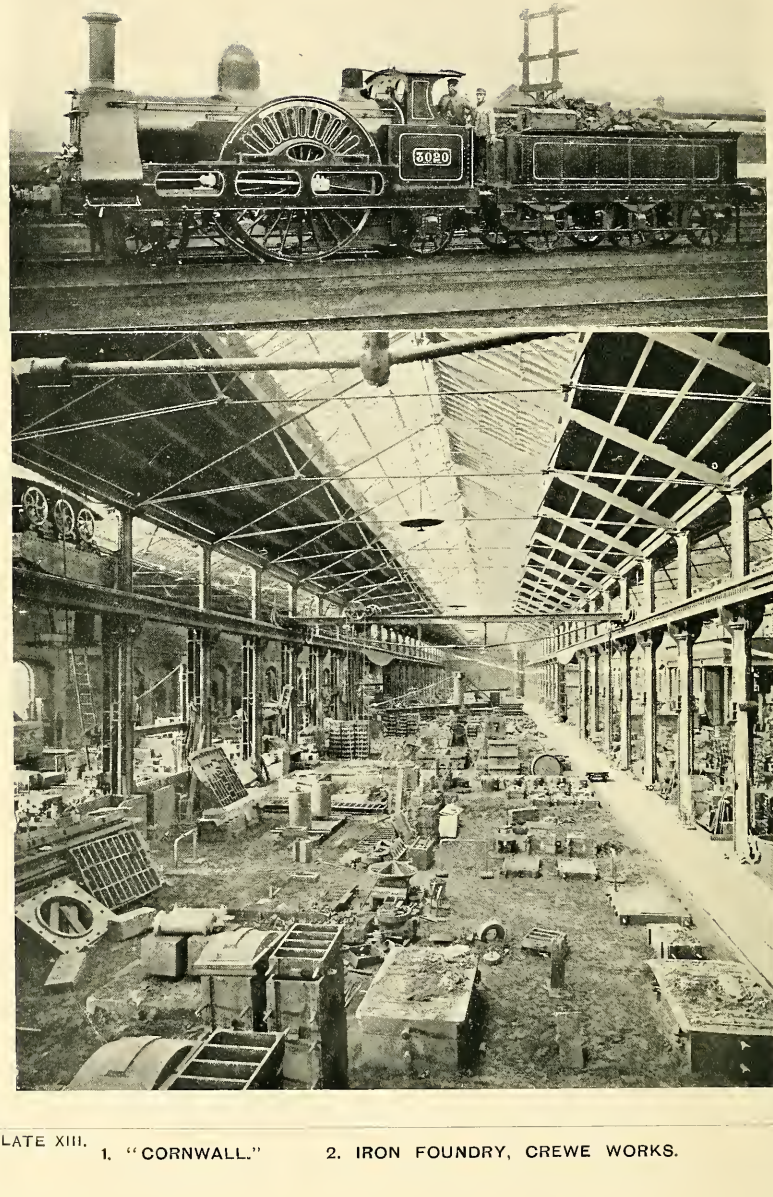


PLATE XIII.

1. "CORNWALL." 2. IRON FOUNDRY, CREWE WORKS.

In August, 1902, was withdrawn from service a famous locomotive, "Charles Dickens," beloved of the public for its name equally with its fine performances. This engine was engaged in the London to Manchester express service; and during its score of busy years it had run at least 2,000,000 miles.

The "Cornwall" (Plate XIII) deserves a paragraph to itself. It was built at Crewe by F. Trevithick, son of the man who first carried passengers by steam-power in 1801. When the engine was first turned out she was a single (4–2–2) with 8 feet 6 inch drivers; weight 27 tons, outside cylinders, and a heating surface of 1046 square feet. She was Trevithick's reply to the broad-gauge engines, and upon one occasion was reported to have done 117 miles an hour down hill. In her first year of service she piled herself up on a coal train, her driver was killed, and she was thrown across the metals. In the year 1862 she was rebuilt and converted into a six-wheeled. In 1897, her jubilee year, the "Cornwall" was working the three-quarter hour express trains between Liverpool and Manchester. Not until January, 1906, was she withdrawn from active service, and is finding shelter at Crewe with "Charles Dickens," and a state coach which the company built for Queen Adelaide. These interesting relics will eventually form part of the L. & N.W.R. museum at Euston.

The London and North-Western Railway commenced work with a capital of £17,000,000, which has grown to £134,000,000, and every hour of its existence the company's receipts amount to £1770, or £15,000,000 per annum. Its 3000 locomotives travel about 48 million miles during the year, of which mileage the passenger engines account for 30 million miles in their conveyance of a quarter of a million passengers a day, including Sundays, and excluding season ticket-holders. Against the huge receipts must be placed the working expenses of £10,000,000 per annum, of which the locomotive service and the traffic expenses amount to more than a half.

The maintenance of the permanent way and the wages of the men who work upon it reach nearly a million and a half sterling. There is a platelayer to each mile of line, every foot of which is examined daily. The total number of employés of all grades is 82,000.

Crewe locomotive works (Plate XIII) employ about 10,000 men; and the prosperity of the whole town of 43,000 inhabitants is wrapped up in the L. & N.W. Railway. In its own furnaces the Company manufactures its own steel, makes huge girders, rolls the 60-feet rails, and fashions a hundred and one metal objects down to the tiniest screws—the Company even makes the wooden limbs, that are required sadly too often, for some of its unfortunate employés. Upon one occasion, when a viaduct was destroyed, in less than a week the works turned out forty girders, each 32 feet long. In addition to such sudden calls upon its resources, Crewe works build about two hundred locomotives a year, besides keeping in repair a stud of, at least, three thousand iron steeds, of which there are generally about four hundred cripples on hand at the same time. Ordinarily it takes four weeks to build a locomotive; but Crewe has accomplished it in 25½ hours, all the necessary parts being ready at hand for fitting together.

At Wolverton carriage works 4000 men keep in repair nearly 10,000 passenger vehicles and 82,000 vehicles for goods traffic; and in addition new vehicles are constantly added to the rolling stock. Earlstown waggon works keep 1500 men very fully employed.

The L. & N.W.R. owns 5000 horses, engaged chiefly in the collection and distribution of the goods traffic; it also rears hens to supply Euston hotel with eggs; and keeps pigs to eat the waste food from car restaurants and hotels.

It is very certain that we have by no means enumerated all the Company's departments of activity upon land; but there is also a London and North-Western afloat, particulars of which will be afforded in Section II.

Here we will leave the London and North

Western Railway Company. To the simple mind, that is liable to take fright at such huge figures, our premier railway company appears easily to justify its proud boast, that it is one of the biggest joint-stock corporations in the whole world.

The Midland Railway

"Midland" was the true name of this Company, for it was formed by a combination of several lines that joined Leeds to Rugby, with branches to Nottingham and Birmingham. The Company speedily got tired of handing its traffic over to others at Rugby for conveyance to London or the coast. In the year 1853, it was proposed to amalgamate the L. & N.W., the Great Western, and the Midland, but Parliament refused to assent to the scheme.

Resolutely the Midland began to push out towards the coast by means of extensions and leasing other lines; it got into Bristol as early as 1846, but not into London until 1857, and then only by favour of the Great Northern. In 1868, however, the Midland ran into the capital on its own metals to St. Pancras; in 1875 it entered Liverpool, and in 1879 it commenced to run expresses from Newcastle-on-Tyne to Bristol.

Nowadays the Midland is one of the most ubiquitous of our lines, as indicated by only a

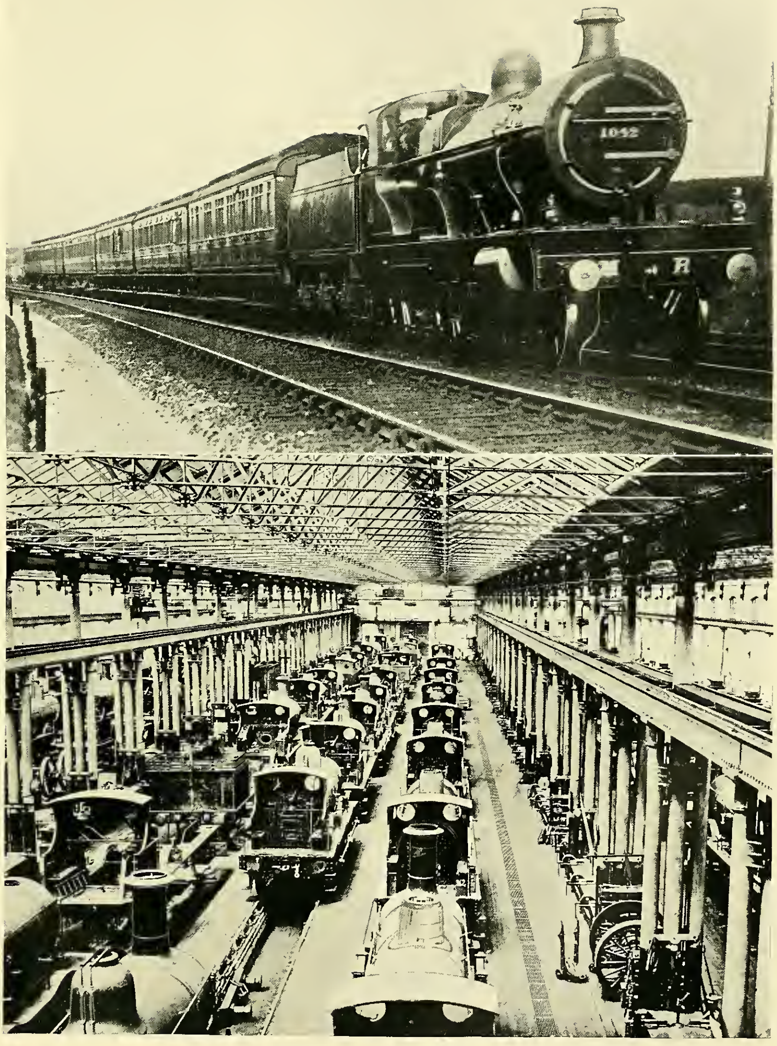


PLATE XIV.

1. M.R. EXPRESS, BRADFORD TO LONDON. 2. ERECTING SHOP, DERBY WORKS.

few of the outermost points of its many ramifications, viz., London, Bristol, Swansea, Manchester, Carlisle, Lincoln, and Peterborough on its own lines; and by joint or leased lines to places as far apart as Liverpool and Lowestoft.

When the section known as the Syston and Peterborough line was built, the surveyors met with the most determined opposition from the Earl of Harborough, who objected to railways in general, and that one in particular. The surveying party of seven dared not venture on to the nobleman's estate and endeavoured to carry out their operations from the canal towing-path adjoining it.

The earl summoned the chief canal officials to the spot and obtained from them a document which gave the nobleman authority to remove trespassers, but at the moment the surveyors were the stronger party. The earl and the canal officials went off to secure reinforcements, but while they were absent a few more local men arrived, and the earl's head gamekeeper arrested the detested railway men. They and their instruments were put into a cart for conveyance to the residence of a magistrate; and the keeper walked behind with a loaded gun in order to defeat any attempt to escape. Upon arrival in the village the constable informed the keeper that he would arrest him unless he released his prisoners; and the keeper in high dudgeon tipped up the cart and shot out the surveyors and their instruments, as though they were a load of coals.

The struggle was renewed the next day, when the surveyors returned to their interrupted task, bringing with them a few prize-fighters from Nottingham and Grantham. Upon the third day a free fight took place between the contending parties; there were broken staffs and measuring chains on one side and broken heads on both; and on the fourth day the Battle of Saxby ended in the police-court, after which the surveying operations went on apace.

On the Midland system there are no less than a dozen tunnels of more than a mile in length, of which the three chief are:—Totley Tunnel (6230 yards), Disley Tunnel (3866), and Cowburn Tunnel (3702); and in the Peak district, in particular, the line is a fine example of railroad engineering. In the Birmingham district the Lickey incline, two miles long with a gradient of 1 in 37, might have been avoided with advantage to the Company's traffic. George Stephenson maintained that no gradient should exceed 1 in 330, but upon many lines the engineers have been unable to keep within that limit.

The longest Midland non-stop run in summer is from London to Shipley (206 miles); in winter to Sheffield (158¼ miles). On Plate XIV is shown a Midland express between Bradford and London. In one important respect the Midland was the pioneer; it was the first company to have third-class carriages on all trains, and it also introduced into the United Kingdom Pullman cars from America. British corridor carriages have now taken their place as on most other lines; but the London, Brighton and South Coast Company still uses the American type. In 1875 the Midland abolished second class, but only a few other companies have yet followed the example.

When the Midland Company put out one of its octopus tentacles to Carlisle, it was not likely long to be kept out of Scotland. It is now a one-third owner of the Forth Bridge.

Now for some comparisons with other railway lines. The lines total up a length of nearly 1800 miles; the turnover annually amounts to £19,000,000; and the mileage of its 2800 locomotives is about equal to that of the L. & N.W.R., but the Midland does not carry so many passengers by some 45 millions. The Midland locomotive works are at Derby (Plate XIV), where 5000 workmen are employed. A new engine is turned out practically every week in the year; but the Company has shown more than a mere liking for American locomotives.

London and South-Western Railway

The L. & S.W.R. is a much more compact system than either of the preceding lines. This railroad was really the outcome of the desire for London to have quicker access to the south coast than by sea; and during the struggles with France, it had been proposed to cut a ship canal from the capital to avoid the danger to which, in war time, shipping was exposed in passing up the Strait of Dover to the mouth of the Thames.

The success of the railway in the North of England set thoughts in an entirely new direction. A line through the region between London and Southampton was what is often called a "tall order," for Southampton had only a population of 19,000, and the next biggest town along the route was Winchester with 8000. This led the humorists to dub the new undertaking the "parsons and prawns" line, for they said the former from Winchester and the latter from Southampton would constitute the main freights; and, indeed, the first locomotive stock was to consist of only five locomotives, two for passengers and three for goods.

The new line was opposed vigorously, especially by people interested in the south coast coaching business. One man owned three score coaches and fifteen hundred horses. He was a wise man; he

PLATE XV.

L. & S.W.R. BOAT TRAIN, SOUTHAMPTON TO WATERLOO.

sold up his business and invested the money in the railway; and in later years he became Chairman of the Directors.

The line was opened in 1840, for the construction had entailed no special difficulties, except where great embankments were required, while steep gradients were necessary to carry the line over the ridge of country running from east to west through Hampshire.

In the year 1844 came the Magna Charta of the third-class passengers. Parliament insisted that on every railway there should be at least one train each way per day at a penny a mile, and that even the humbler passengers were to be protected from the weather. The L. & S.W.R. complied with rather a bad grace. The coaches were roofed, but lighted only by skylights; the ventilation slits were placed high up and were covered with a curtain, so that those who travelled at the Parliamentary rate should not enjoy the beauty of the scenery into the bargain.

Naturally the London and South-Western and the Great Western Companies were keen rivals. In 1863 the former was running trains at 25½ miles an hour, and four years later claimed that its London to Southampton expresses were the fastest in the world, covering the distance of 79 miles in one and three-quarter hours.

The Company experienced the usual misfortunes incidental to the early lines. The branch from Southampton to Dorchester was a single line for the greater part of the distance. On September 20, 1847, the mail train was over-due at Wareham, and the station-master despatched a pilot engine along the line to discover its whereabouts. It was something like looking for an escape of gas with a light; for the pilot engine only found the missing "flier," when it hurtled into it with all the unnerving accompaniments of a tremendous collision.

Passengers in these early days had little faith in the rail-points. At Kingston station the Guildford train had to shunt on to the down-line for the Southampton express to pass. The passengers in the slow train usually preferred to leave their seats and wait by the side of the line until the express had gone on its way.

The capital of the London and South-Western Railway is only half that of the Great Western, and its lines are only half the length of those of the Midland. Though the train mileage is only 20,000,000 miles, it carries 63 millions of passengers, or nearly twenty millions more than the Midland.

The locomotives number less than 800, and a great proportion of them are tank engines for the London suburban services, which chiefly account for the heavy passenger traffic. The longest non-stop runs are from Waterloo to Bournemouth, 107 miles ; Salisbury, 83 miles ; and between Salisbury and Exeter, 88 miles. From Waterloo to Exeter is two miles shorter than by any other route, while to Weymouth there is a saving of six miles. The express service, Waterloo to Exeter in three and a half hours with a stop at Salisbury, is excellent running.

Since the inception of the L. & S.W. Railway Southampton has waxed big, and it is now one of the most famous ports in the world. On Plate XV is shown a boat train from Southampton to Waterloo. The Company owns docks and quays, and a fleet of twenty steamers, plying chiefly to the Channel Isles and France.

CHAPTER IX

A GARLAND OF IRON RIBBONS

PART II

THE history of the Great Western Railway Company is the story of the broad-gauge lines that have now been swept away. The battle of the rival gauges is not only connected with some of the most exciting events in railway history, but it was responsible in a very great degree for the rapid progress made by British railways within the very first few years of their introduction.

As early as 1825 Bristol merchants were talking of the new means of communication that was opening wide the eyes of the travelling and business world. London and Bristol trade was conveyed largely by water, and the inland waterways were often hard hit in summer by drought, and in winter by frost.

In 1835 the trains on the London to Birmingham line were running the 113 miles in $6\frac{1}{4}$ hours; but the projectors of the Great Western proposed to accomplish the distance between London and Bristol, 118 miles, in 4¼ hours. It may be guessed what the wiseacres foretold concerning attempts at any such speed. There was the usual opposition to the route proposed by Brunel, who was the engineer. When at length Parliament gave consent, the authorities of Eton School got inserted in the Bill that there should be no station at Slough, and, further, that the line should be patrolled by railway policemen in that neighbourhood for the protection of the scholars.

Most of the lines already constructed in the Kingdom were 4 feet 8½ gauge, although on the Eastern Counties line it was 5 feet, and in Ireland it was 6 feet 2 inches. Brunel decided to adopt a width of 7 feet. His reasons were that the greater width allowed of the use of more powerful locomotives, exerting more tractive force for goods, and more speed for passenger trains. Last, but not least, he intended to sling his coaches between the wheels, just as in the case of ordinary coaching vehicles; but he never put this idea into practice.

On June 4, 1838, was opened for traffic the first section, 22½ miles from London to Maidenhead. It was not a commencement likely to fill Brunel with undue pride. The locomotive "Æolus" put out its boiler fire by means of a leaking tube, and at West Drayton there was a delay of over an hour, while a fresh engine was procured. Five months later, however, the engine showed its paces by drawing three coaches at the rate of 48 miles an hour.

From the outset the management of the Great Western has been noted for its progressiveness; and it was in keeping with this character that in 1839 the Company laid down Cook and Wheatstone's telegraph from Paddington to West Drayton. The telegraph was another apparatus that drew forth the scorn of the sceptics. Their conversion, however, was at hand. Near Slough a particularly atrocious murder was committed, and the criminal took train for Paddington. When the railway officials heard the description of the suspected man, they telegraphed to London, where the man, greatly to his astonishment, was arrested upon his arrival. No despised innovation ever had a better advertisement, and all disbelief in the electric wire died a violent death.

We will take a rapid survey of the completed line from London to Bristol, which was opened on June 30, 1841. Box Tunnel (p. 81), 98½ miles from London, is approached by a deep cutting over two miles in length, and the rails lie 270 feet below the crest of the hill. The suggested tunnel met with the most strenuous opposition, and George Stephenson, when giving evidence in favour of the work before a Parliamentary Commission, was told that no passenger would ever make a

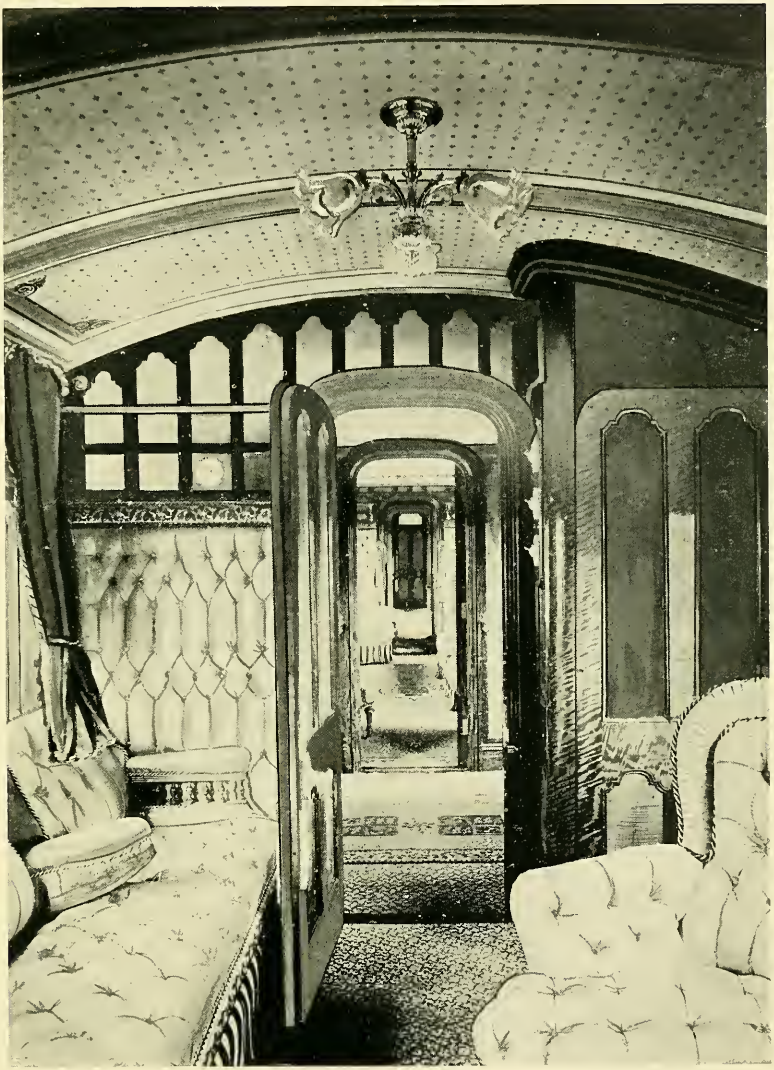


PLATE XVI.

G.W.R. ROYAL SALOON.

second unnerving passage of the black depths in which there is a fall of 1 in 100. After the line was open passengers frequently left the train at the station nearest the mouth of the tunnel, and posted over the hill to the next station.

Brunel himself had occasion to remember Box Tunnel, through which only one line of rails was laid. At eleven o'clock at night the famous engineer was bringing the up-train through, when to his alarm he discovered that the policeman at the top end had signalled the down mail train on. If the tunnel had not been clear of smoke and steam, the mail train lights could not have been perceived, and a collision would have been inevitable. There was just time for Brunel to reverse and dash back down the incline to Box station, where the mail train passed him. Not a little disgusted at the delay, Brunel again proceeded into the tunnel, where the engine fouled the rails, and kept the engineer in the heart of Box Hill all night.

Another great undertaking in the construction of the line was the spanning of the Brent valley by the Wharncliffe Viaduct, an eight-arched erection, 300 yards in length, 70 feet in height, and approached by a long embankment.

In later years the Severn Tunnel (1873-85) proved to be a very serious task. Including approaches the tunnel is 4½ miles long, and in the brickwork lining 60,000,000 bricks were used. For sixteen months the excavations were flooded, and it was only by the employment of enormous pumps and the assistance of divers that at length the water was overcome.

The new line was remarkably free from accidents, and by the time the Great Western Railway had carried 3,000,000 passengers, the casualties were only a broken leg and a fractured arm. The Prince Consort was an early and frequent patron; but Queen Victoria did not venture on a journey until 1842. That Her Majesty might not be inconvenienced by the rattle of iron tyres on the metals, her special saloon was provided with wooden wheels. On Plate XVI is shown a Great Western Royal saloon, which was used regularly by Queen Victoria in later years. H.M. King Edward VII. travelled in this saloon from Paddington to Windsor on January, 1901, to attend the funeral of his royal mother; and on May 20, 1910, the body of King Edward was borne in the same vehicle from London to Windsor for interment.

The first locomotive superintendent of the Great Western line was Daniel Gooch, who had learnt his business at Stephenson's Vulcan Foundry. Before Mr. Gooch entered the service of the Great Western Railway, Brunel had ordered engines from Newcastle. There happened to be in stock a couple that Gooch had designed for use on a

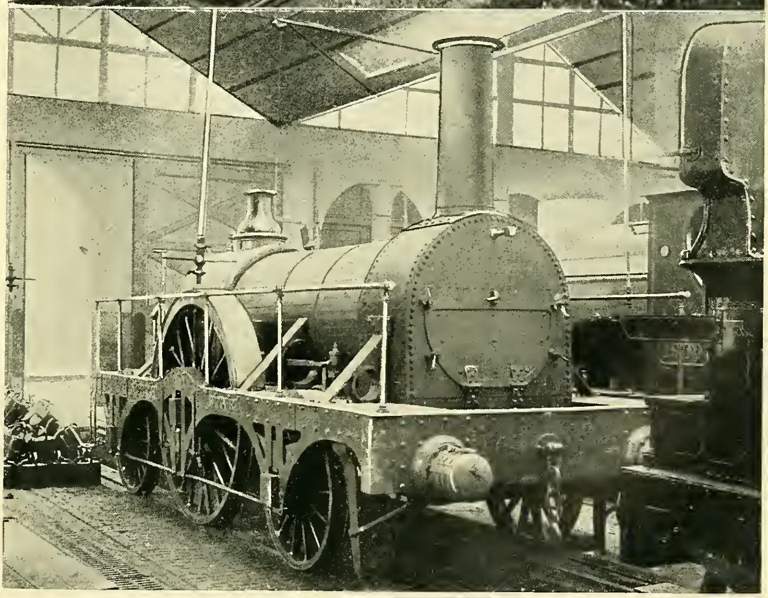


PLATE XVII.

MIXED GAUGE LINE. "NORTH STAR."

railway in Russia. Stephensons' had demanded payment for them before delivery, and failing to obtain it, they were altered to suit the 7 feet gauge; and thus two of Gooch's first engines were of his own design and built under his own superintendence, little dreaming how long they ultimately would be in his care.

Mr. Gooch's first engines were of the "Fury" type, some with 7 feet driving wheels, and others with 6 feet drivers. In the first the heating area was 700 square feet and in the second 608 square feet. In one feature some of Gooch's earlier engines were unique; they were fitted with steel tyres. Steel was then dear and could not be afforded for engine and tender bodies. The results were noticeable in the life of the wheels, some of which ran 300,000 miles before being retyred.

Within four years of commencing business, the Great Western Railway had nearly doubled its length of line, and it was the largest of the seventy railroads that were open for traffic. The Midland was second at that time with 180 miles. At the end of another twelve months the Great Western Railway locomotives had increased to 121, or four more than the London to Birmingham line could boast. It was in this same year that was introduced the cloak-room system, on practically the same lines that are followed to-day.

It was found that the broad-gauge was a

hindrance to the speedy transport of goods at the points where other lines touched the Great Western system. Narrow-gauge rolling stock could not run on the broad-gauge and vice-versa, necessitating the transhipment of goods, causing delays and additional expense. A difference in gauge affected passengers in a lesser degree. Persons could change trains with greater ease than coal and general merchandise could be moved. Where the Great Western and other lines worked in concert the gauges were "mixed," that is, a third rail was laid down, so that a train could take the two rails that fitted it (Plate XVII).

Opponents of the broad-gauge commenced to clamour for its conversion to narrow, while Brunel, Gooch and their friends strained every nerve to prove that their system was superior to all others. On the London to Birmingham line the express trains were doing 23½ miles an hour; and in May, 1845, the Great Western Railway "Cornishman" commenced to run to Exeter, 192 miles in 4½ hours, or very nearly 44 miles an hour. The best trains nowadays only effect the journey 35 min. quicker, which does not seem a tremendous improvement in half a century.

A Parliamentary Commission inquired into the question of the rival gauges, at which time there were 274 miles of broad-gauge, while the narrow-gauge lines were seven times as long. Tests were

PLATE XVIII.

G.W.R. CORNISH RIVIERA EXPRESS.

arranged for each system, which resolved themselves into a contest between the locomotives of the Great Western and those of other companies.

The 43 miles from York to Darlington formed the narrow-gauge racing track. With a boiler fed with warm water and a flying start, a train of 50 tons completed the distance at 35 miles an hour; in a second trip the rate rose to 48 miles; and in the third trip the narrow-gauge engine ran 22 miles in 27 min. and then left the metals.

The Great Western racing track was from London to Didcot, 52 miles. The broad-gauge enthusiasts scorned warm water for the boiler and started from rest. They laughed at a load of 50 tons, and took 31 tons additional just for luck. The first trip occupied 64 min., and on the return journey four minutes were knocked off; the average rate was 47½ miles an hour; lightening the load to 70 tons reduced the time to 56½ minutes, or 55 miles an hour.

In the report of the Commission it was acknowledged that, so far as engines and speed were concerned, the victory lay with the broad-gauge, but even marked superiority in speed did not atone for such hindrances to commerce as breaking bulk of goods in transit, etc. The broad-gauge stalwarts had fought to the last ditch, but the day went against them.

Although there were many miles of "mixed" gauge on the Great Western system, to transform the whole into narrow-gauge was a tremendous task. A seven mile branch line was first changed, in order to gain experience that would render useful service when a longer section was in question. In 1869 the 22½ miles of metals between Gloucester and Grangemouth were converted; and if we take note of the operations, we shall better understand what it meant to change the nature of the main lines.

Four hundred and fifty men were engaged from Sunday morning until the following Thursday night, during which time the workmen did not take off their clothes, and only 3½ hours' sleep was allowed each night in the covered waggons at the side of the line. During the course of the work 85,000 chair bolts were withdrawn, and as many fresh holes bored in the sleepers; the chairs were refixed, and a rail moved 27½ inches inwards. In 1872 the line from Swindon to Milford, 312 miles, was changed, followed by another 200 miles a couple of years later; and not until 1892, when the 106 miles between Truro and Exeter were converted, did the broad-gauge make its final disappearance.

In 1906 were broken up the "North Star" and the "Lord of the Isles" (Plate XVII), two famous Great Western locomotives. The first-named was in service from 1838 to 1870, during which it ran

429,000 miles; and the latter, one of Gooch's best-known "singles," ran for thirty years after it was shown at the Great Exhibition in 1851. It is a matter for regret that we do not possess a national railway museum, where such interesting relics of the early days of our great railway systems might be systematically preserved.

Now we will consider the Great Western's share in our bunch of iron ribbons. There are, first, three very great streamers extending from London, viz. to Chester, Milford Haven, and Penzance; and perhaps you would like to count the towns between those points that are served by the famous Company. A few quick runs from London are: Bristol, 117 miles in 2 hours; Exeter, 173¾ miles in 3 hours; Plymouth, by the "Cornish Riviera" express, 226 miles in 4 hours 7 min. (Plate XVIII); while we can get to Ireland *via* Fishguard on the Welsh Coast.

The Great Western narrow-gauge locomotives show the same excellent points that were observable in their broad-gauge engines. Mr. G. J. Churchward's six-coupled bogie expresses are hard to beat. No. 28 "Vanguard," with 400 tons behind it, has run from Swindon to Ealing, 71½ miles, in 70 minutes. In July, 1903, the "City of Bath," with the Prince and Princess of Wales as passengers, ran from London to Plymouth, 245 miles, in 233½ minutes. On this route, in 1906, an additional section of line provided a short cut by which 20 miles are saved, but even now the booked runs do not equal the performance of July, 1903, by 15 minutes.

The Great Western route from London to Fishguard is 261½ miles. It was desired to see what a good engine could accomplish at its best, without making it a special racing effort. No. 3408 "Atbara" type (4–6–0), with drivers of 6 feet 8 inches, 1818 square feet heating surface, and a steam pressure of 195 lbs., ran to the Welsh Coast in just under 5 hours, or quite 52½ miles an hour—on the return journey the engine improved the time by five minutes.

In 1908 was placed upon the rails the "Great Bear" (Plate IV), which was Britain's first locomotive of the "Pacific" type (4–6–2), and the largest engine hitherto seen on our railways, although it is smaller than American engines of the same type.

In 1909 the Company brought into service a new series of 4–6–0 express passenger engines with four high-pressure cylinders. They were practically of the same type as the "Star" and "Knight" classes (Plate III), with but slight differences in detail. There were ten engines in this new "King" class, which still are among the heaviest running in this country, weighing 75½ tons exclusive of the tender, which weighs 40 tons when full.

PLATE XIX.

G.E.R. BOAT TRAIN, HARWICH TO LIVERPOOL STREET.

No. 4021 "King Edward" drew the Royal funeral train from Paddington to Windsor on May 20, 1910, when the mortal remains of King Edward VII. were conveyed to their last resting-place; and five other engines—"King William," "King James," "King Charles," "King Stephen," and "King George"—drew the remaining trains, which carried the distinguished guests invited to take part in the ceremony at St. George's Chapel.

The train bearing the remains of the departed King and the chief mourners consisted of the violet-draped funeral saloon which was used on a similar occasion nine years previously, when Queen Victoria was conveyed to her last resting-place in the mausoleum at Frogmore, ten saloon coaches to accommodate the Royal mourners and their suites, and a brake van. The engine appointed to haul this train was doubtless chosen for its melancholy appropriateness, No. 4021 "King Edward," and was driven by Mr. W. Butcher. At no time in the previous history of railways has any one man with his hand on the regulator controlled to an equal degree the destinies of Europe. One slight lapse of judgment on his part might have plunged the whole world into mourning and into a chaos that would be more terrible still. Mr. G. J. Churchward, the chief mechanical engineer of the G.W.R., also rode on the engine, and the Chairman and leading officials of the railway accompanied the Royal train.

The engine was suitably decorated for the sad occasion, bearing at either side the Royal coats of arms on a "field" of purple, and small crowns on the head lamps. We illustrate the engine as thus decked, in Coloured Plate B.

At the Swindon railway works 13,000 employés receive £16,000 in wages per week, and as Swindon is a town of only 50,000 inhabitants, the whole borough, like Crewe, is practically an integral part of a great railway system.

The capital of the Great Western Railway Company is about two-thirds that of the L. & N.W.R., but its lines (2950 miles) are longer than those of any other British company; its train mileage exceeds even that of the L. & N.W.R., and it carries annually 10,000,000 passengers more.

In the short space that remains for this chapter can be attempted only a very brief review of six or seven of our railway systems, each of which presents some special feature of interest.

The Great Central Railway dates only from August, 1897, having been known previously as the Manchester, Sheffield and Lincolnshire Railway, whose operations lay chiefly from east to west. Only in 1899 were 92 miles of new line opened from Annesley, a few miles north of Nottingham, to London. To reach the terminus at

PLATE XX.

FIVE TRAINS IN MOTION OUTSIDE LIVERPOOL STREET STATION.

L.B. & S.C.R. "SOUTHERN BELLE."

Marylebone it was necessary to tunnel under Lord's Cricket Ground. The Company is greatly interested in the North Sea trade, and owns the extensive docks at Grimsby, the greatest fishing port in the world. Over $2\frac{1}{2}$ million tons of coal are shipped here in a year; vast quantities of timber arrive from Scandinavia and the Baltic; and the fish trade is immense. The Great Central's longest non-stop run is from London to Sheffield, $164\frac{3}{4}$ miles in 2 hours 57 min., or at a fraction under 56 miles an hour. Another excellent service is London to Leicester, 103 miles in 1 hour 49 mins., which works out at a little over 56 miles an hour.

The Great Eastern Railway is one of the few very important lines whose title really covers its field of operations. The system serves East Anglia with a network of rails, out of which extends only one important joint line from March to Doncaster. The Company has 1085 locomotives running on 1200 miles of line, upon which over 90 million passengers travel annually, exclusive of season-ticket holders. The Great Eastern provides an important outlet to the Continent *via* Harwich, its expresses accomplishing the 70 miles in 90 mins. (Plate XIX). Liverpool Street Station (London), with its eighteen platforms, is one of the most important stations in the Kingdom. An enormous number of trains enter and leave it daily. On Plate XX is shown an adjacent stretch of line, known as Bethnal Green Bank, where five trains are passing each other.

Most of the British railway companies provide facilities for the education and training of their servants, and, up and down the country, there are many excellent Mechanics' Institutes, where young railway employés may receive sound technical instruction. The Great Eastern Mechanics' Institution was opened in the year 1851, and was the first educational establishment of its kind in the East End of London. In the year 1903 the Directors adopted a scheme by means of which deserving students could proceed to the higher branches of education, devoting whole sessions to study, without the forfeiture of wages. In less than seven years the scheme bore fruit, for Great Eastern students secured two Whitworth Scholarships and five Whitworth Exhibitions, and four students passed the final test of the London University for the degree of Bachelor of Science (Faculty of Engineering). At the Locomotive and Carriage Works, Stratford, London, E., practical classes are open to employés free of charge, and without deduction of pay, when the studies infringe upon the ordinary working hours.

Railway men, such as drivers, firemen, and guards, often find themselves very many miles from home, when a train is brought to a standstill

PLATE XXI.

G.N.R. EAST COAST EXPRESS TAKING UP WATER WHILE AT FULL SPEED.

at the end of a long run. The men are in urgent need of rest in order to be refreshed by the time they resume duty on the return journey. Most railway companies have a list of approved and convenient lodging-houses, where their servants can secure comfortable apartments; and arrangements are made to awake the employé in time to resume duty.

Mr. J. Holden, for many years Locomotive, Carriage, and Wagon Superintendent of the Great Eastern Railway, instituted an Engine Men's Dormitory at Stratford for the Company's drivers and firemen, when perhaps 180 miles from home. It was opened in November, 1890, with 20 beds; and in July, 1891, the building was extended, and the accommodation raised to 50 beds.

Upon entering the Dormitory the engine man is registered and particularly the time is recorded at which he has to resume duty, so that an official may know when to awake him. Proceeding to the kitchen the visitor hands to the steward the food which he requires to be prepared for a meal, or a messenger is at hand to procure food from the neighbouring shops. By the time the engine man has enjoyed a hot or a cold bath, and exchanged his shoes for slippers, his meal is ready.

The meal at an end, the visitor can retire to rest in a well-appointed cubicle with a comfortable bed and clean sheets, which are supplied to every occupant; but as he has at least a rest of nine hours, he may prefer to betake himself to the recreation and reading room, to peruse a daily paper or magazine, or chat with other footplate workers.

No less than 117 engine men have rested in the Dormitory in the course of twenty-four hours; the weekly average is about 370, although at exceptional times the number has risen to 500. Since the opening of the establishment about 400,000 visitors have enjoyed the hospitality of this railway man's hotel, for which a charge of 1*s.* 3*d.* is made, which is half the amount allowed by the Company for lodging purposes.

The founder of the Dormitory retired from office at the end of 1907, and was succeeded by his son, Mr. S. D. Holden, who takes the liveliest interest in the institution, and the men who use it. When pressure of work has kept the Locomotive Superintendent, day and night, for a whole week at Stratford, he has not hesitated to make use of the Dormitory, as though he were an engine man himself, which is an excellent testimonial to the comforts offered by the rest-house.

The South-Eastern and Chatham Railway is a working combination of the South-Eastern and the London, Chatham and Dover lines. The total length of line is 646 miles; passengers carried,

PLATE XXII.

NORTH BRITISH EXPRESS LEAVING WAVERLEY STATION, EDINBURGH.

60,000,000; locomotives, 748. The longest non-stop runs are Victoria to Dover, 78½ miles; Charing Cross to Folkestone Junction, 71 miles; and St. Paul's to Margate, 74 miles.

The London, Brighton and South Coast Railway has 483 miles of line; passengers, 48,000,000; and 535 locomotives, some of the latest of which are heavy tank engines fitted with superheaters for express work. The quickest train is from Victoria to Newhaven, 56 miles in 81 mins. This Company introduced Pullman cars over thirty years ago and, unlike the Midland, has retained them. Over thirty of them are in constant use between London and various South Coast watering places. The "Southern Belle" express (Plate XX) commenced running in November, 1908; Pullman cars are used exclusively, and make the train probably the best appointed and the most luxurious in the whole world.

The East Coast Route to Scotland is the shortest and quickest, for racing records are not always reduced to actual time-table practice. The three partners in this service are the Great Northern, the North-Eastern, and the North British lines.

The Great Northern main line extends from King's Cross to a little beyond Doncaster, but for practical purposes York may be deemed the northern limit. A long non-stop run is from

London to Doncaster, 156 miles in 169 minutes; to Wakefield, 175¾ miles in 189 minutes, is longer, but the latter part of the journey is run on a joint line. The "Flying Scotchman" (Plate XXI) is a famous express train that travels to Aberdeen *via* York, Newcastle, Edinburgh and Forth Bridge; the 523 miles are accomplished in 11 hours 20 mins. Stops at the three towns mentioned absorb twenty minutes; deducting this time the actual running is 47½ miles an hour over the very long distance. There are nearly 1300 Great Northern locomotives, and some of their performances are noted elsewhere; for many years the 8 feet "singles" vied with the broad-gauge "Lord of the Isles" type. The locomotive works at Doncaster employ 4500 hands.

The North-Eastern system extends from the northern limit of the Great Northern to Berwick; the main line on the right throws off a network of metals to the towns on the north-east coast, and on the left is an equal web of branches, forming in all 1700 miles of track. The longest non-stop run is from Newcastle to Berwick and then by the North British line to Edinburgh, 124½ miles in 2 hours 20 mins. Plate XXII shows a North British express leaving Waverley Station, Edinburgh, for the south. The Company owns 2000 locomotives; and in its own waggons carries more coal and minerals than any other company.

PLATE XXIII.

L. & N.W. AND C.R. WEST COAST EXPRESS.

The North British is a Scottish line, with running powers over some English lines as far south as Hexham and Carlisle. The three partners in the East Coast Route are joined by the Midland Railway in the ownership of the Forth Bridge, which was opened by King Edward, when he was Prince of Wales, in March, 1890. The Marchioness of Tweeddale drove the first engine over the estuary. The North British Company is responsible for the upkeep of the bridge, which is 1 mile 1005 yards long exclusive of approaches; the rails are 160 feet above the water. In this great engineering work are over 54,000 tons of steel, 40 miles of plates, and to secure the tubes alone 5 million rivets were used. It takes three years to paint the bridge. Sixty men are constantly employed in keeping the structure and the permanent way in order. Though this Company owns 1300 miles of track, it has only a hundred locomotives.

The West Coast Route to Scotland is the concern of the London and North-Western as far as Carlisle, from whence to Aberdeen the trains travel on the main line of the Caledonian Railway. We already know the English share in the West Coast record (p. 69). From Carlisle the Caledonian engines took up the running. The first section to Perth includes the summit level between Beattock and Elvanfoot, yet the average speed was $60\frac{1}{2}$ miles an hour; and in the last part of the journey the rate was quickened by nearly 5 miles an hour. Two engines to earn renown upon this occasion were the "Adriatic," 7 feet compound, and the "Hardwicke," 6 feet 6 inches, four wheels coupled.

If the race had come a year later, when the new type "Dunalastairs" was put upon the metals, the result might have been even better. These engines made railway history, not in racing, but in regular booked times, which are far more valuable. A few examples must suffice to show the capabilities of the "Dunalastairs" with loads of 200 tons: Perth to Forfar, $32\frac{1}{2}$ miles in 32 min.; Carlisle to Stirling, $117\frac{3}{4}$ miles in 125 minutes (Plate XXIII), and Stirling to Perth, at $56\frac{1}{2}$ miles an hour regardless of an incline, 1 in 73, at Dunblane-Kinbuck, are running feats worth remembering. The longest non-stop run is Carlisle to Perth, $150\frac{3}{4}$ miles in 3 hours.

Of the Irish lines the Great Northern, with 587 miles of track, though not the longest, is the most important system. It owns 164 locomotives, and carries $6\frac{1}{2}$ million passengers annually. The longest non-stop run is from Dublin to Drogheda, 32 miles. The Great Southern and Western Railway, with over eleven hundred miles of line, has only 283 locomotives. Its quickest service, Dublin to Cork, 166 miles, is the "White Star" American mail express for Queenstown. The Belfast and

PLATE XXIV.

BELFAST TO DERRY EXPRESS (NORTHERN COUNTIES COMMITTEE).

Northern Counties Railway amalgamated with the Midland Railway in 1903. Some of the chief towns served are Belfast, Larne, Londonderry, Antrim, Coleraine, etc. One of the best services is from Belfast to Londonderry (Plate XXIV).

CHAPTER X

WITH THE TRANS-CONTINENTALS

OUTSIDE the United Kingdom, nowhere were the efforts of our steam traction pioneers watched more interestedly than in America. We urgently needed more rapid transit to cope with our ever-increasing trade, which was growing utterly beyond our network of high-roads and canals; but in some regions railways were required for expansion, and actually to create trade.

The United States

In the United States the case was entirely different from our own; it might almost be said that they possessed no high-roads except in the New England States. Their first roads to a very great extent were to be railroads, for as soon as the success of the locomotive was established, the Americans suffered from railway fever, quite as much as we did in the Old Country.

In 1832 the States possessed 230 miles of railway; in ten years they had increased nearly twenty-fold; in 1860 there were 30,000 miles; in 1880, 100,000 miles; and at the beginning of the twentieth century, 200,000 miles of railed track. In the United Kingdom the railway engineer schemed and planned so that his line might touch as many towns as possible, in order to collect traffic; in the United States railroads appeared to lead nowhere—they were not to serve a population, but rather to attract one. The forceful energy and faith of the American railroad men were justified; the iron-road was the pioneer of civilization, of population, and an amazing increase of trade.

America is the land of huge distances, and a railway usually meant a much bigger undertaking than in little Britain. Railway tracks were laid at breakneck speed, for the dictum of Edward Pease, that the "construction must be solid," did not enter into the consideration of the Yankees, whose motto was rapidity, and leave the solidity to take care of itself. American track worked out at £12,000 a mile, whereas in Great Britain it was nearly four times as much, and the difference was not caused solely by the price of the land.

In the United States there are three companies each owning more than 10,000 miles of railway, and there are thirty about equal to our Great Western Company. The companies are on a big scale, and so is their business. Let us compare American and British figures, for there is scope in them for surprise as well as interest. The American lines in a year carry 600,000,000 passengers, whereas we carry about twice as many; yet the American passenger receipts are far bigger in total than ours, for the simple reason that Brother Jonathan travels longer distances. In the United Kingdom the average fare per passenger per journey is $9\frac{1}{2}d.$, but in the States it is about thirty shillings.

When we come to compare the carriage of goods our little island is completely out-classed. Where we carry 500 million tons the United States railways carry double the traffic, while it brings into the companies' coffers four times as much in rates, distances again telling heavily.

When we come to examine the railway tracks, we find something upon which to plume ourselves. Our lines were always well constructed from the first; there have naturally been great improvements during the passage of years, but the tracks are the original ones; whereas in America many of them have had to be relaid to stand modern conditions.

British railways were constructed to fit in with crowded areas, and the rails were laid with a view to the protection of life and limb. But in many of America's most crowded districts the railway was there first, and towns and town life have had to fit in with the railway. There are level crossings in our country, but they are usually where the population is sparse; in America trains rush along unfenced tracks not only in the open country, but even in many of the large towns.

Chicago is the great railway centre, and until twenty years ago its streets were crossed and recrossed by the rails of no less than twenty-one companies; and in a city with a population about four times that of Birmingham, there was no wonder that as many as four hundred persons a year were struck down and killed in the streets. This annual death-roll caused the Government to compel the railway companies either to elevate their tracks above the streets, or depress them beneath. What this conversion meant in the very heart of a great city the reader can easily imagine. In many cases, not only in Chicago but other cities, there came into existence elevated railroads, an example of which will be described in the next chapter.

The growth in the goods traffic of the American lines is one of the marvels of modern commerce. Larger waggons were constructed that would hold 100,000 lbs. or 1000 bushels of wheat. To haul trains of bigger waggons necessitated more powerful locomotives. Now the American engineers are not hampered like their British brethren, who have to take care that their rolling-stock fits the thousands of bridges and tunnels. In America there are comparatively few of either, and in addition the space between the two sets of metals is seven feet, instead of our "six foot." American locomotives can easily be eighteen inches wider than ours, and that extra width counts for a very great deal in the fire-box.

In some past chapters there are frequent references to American locomotives in comparison with British. Even at the risk of repetition, it will be well to note a few special performances.

On the New York Central line, No. 3381 "Atlantic," working the Empire State Express from New York to Buffalo, ran 440 miles at 53 miles an hour. On the Atlantic City railroad, No. 1027 four-cylindered compound has a specially large boiler extending over the trailing wheels. For two months this engine never occupied more than 47 minutes in travelling the 55½ miles between Philadelphia and Atlantic City; and upon quite twenty days the time was below 47 minutes, or 70 miles an hour.

The Pennsylvanian Railroad boasts of a fine long-distance speed record from Pittsburg to Chicago, 468 miles in 7 hrs. 42 min., at an average speed of nearly 61 miles an hour. Never before in America or elsewhere has so high an average been

PLATE XXV.

SOUTHERN PACIFIC EXPRESS, U.S.A.

maintained over so great a distance. Really the actual speed attained was at least 62 miles an hour, for the train was stopped four or five times, causing it to lose well over twelve minutes.

The Lake Shore and Michigan lines have engines of the "Prairie" type (2–6–2), working the "Twentieth Century Limited" between Chicago and New York. The specifications of the engine are worth attention: weight of engine, 117 tons; tender, 72 tons; $20\frac{1}{2}$ in. cylinders, 28 in. stroke; driving-wheels, 6 ft. 8 in.; fire-box, 7 ft. by 7 ft.; 344 tubes; total heating area, 3597 sq. ft. The tender holds 13 tons of coal and 6000 gallons of water.

An engine of such proportions should attain something out of the common, and to run 960 miles in 956 minutes comes well within that category. Plate XXV depicts a Southern Pacific express hurtling along an unfenced track.

On page 138 reference was made to the Great Western's locomotive, the "Great Bear," Pacific type (4–6–2). If we place a British "Pacific" by the side of an American, we shall see more readily the points of resemblance and difference.

	British.	American.
	Great Western Railway, No. 111.	Pennsylvanian Railroad.
Cylinders	4–15 ins. by 26 stroke	2–24 ins. by 26 stroke
Drivers	6 ft. 8½ ins.	6 ft. 8 ins.
Heating	3400 sq. feet.	4427 sq. ft.
Pressure	225 lbs. per sq. in.	200 lbs. per sq. in.
Coal	6 tons	11 tons
Water	3500 galls.	7000 galls.
Weight with tender ...	143 tons	187 tons

A British engine need not concern itself greatly about the difference in water-carrying capacity, since water troughs will atone for it ; but at most points the American is suggestive of more power and speed.

Canadian Pacific Railway

The construction of a railway more than 2900 miles long, with 300 miles of its track cut through solid rock, is no light undertaking. In 1875 the Canadian Government commenced this great work, but little progress was made until the Canadian Pacific Railway Company took it in hand. The contract time to complete the line was ten years, but the feat was accomplished in 1885, nearly six years earlier than agreed. The work was one of the greatest engineering achievements of modern times. As in the case of the United States, civilization followed in the wake of thirty to forty thousand navvies, many of whom were Chinese with sprinklings of dozens of other nations; and ere the completion of the line, villages and towns were springing up at favourable points along the route.

Starting from Montreal, the principal eastern terminus, the line follows the north bank of the River Ottawa, until the capital is reached, where the river is crossed. It is not until the second morning from Montreal that Lake Superior comes in sight. Winnipeg is the next great landmark, the half-way house to the Pacific. Regina is the next important centre on the line. At Medicine Hat Indians are often seen on the station platform, decked in their war paint, but having nothing worse in view than selling polished cows' horns to the passengers, whom they hope will view the horns as trophies of the buffalo chase and will pay for them accordingly.

For many miles there is a steady ascent until, at Calgary, a height of about 3400 feet above sea level is reached, and the snowy peaks of the Rockies stand out clearly in the distance. After leaving Banff there yet remain nearly 600 miles of magnificent scenery before the Pacific coast is reached. The line still ascends until the summit is reached about 800 feet higher, and then the train glides along to the celebrated Kicking Horse Pass, in which the line drops 1300 feet in the course of ten miles.

The scenery is now sublime and almost terrible in its grandeur. The line clings to the mountain side at the left, and the valley on the right deepens until the river is seen as a gleaming thread a thousand feet below. Near the head of Mount Stephen is a ridge, and on its shoulder almost overhead is seen a shining green glacier, 800 feet in thickness, which is slowly pressing forward and over a vertical cliff of a great height. The line ascends again for a short distance, and then commences the descent of the Lower Kicking Horse Valley.

The cañon rapidly deepens until the mountain sides become vertical, rising straight up thousands of feet, and within an easy stone's-throw from wall to wall. Down this vast chasm go the railway and the river together, the former crossing from side to side to cut ridges out of the solid rock; and twisting and turning in every direction, and every minute or two plunging through projecting angles of rock which seem to close the way. With the towering cliffs almost shutting out the sunlight and the roar of the river and the train increased a hundred-fold by the echoing walls, the passage of this terrible gorge is never forgotten by the passenger.

Very soon the train again begins to climb, running along a ridge cut out of the side of the mountain a thousand feet above the valley. Mountain torrents and deep gorges are spanned by bridges, and the great height at which the chasms are crossed makes the passenger almost afraid to look upon the grand but awful scene beneath. In places the engineers have had to guard against avalanches and snow-slides, and they have successfully accomplished their task by erecting snow-sheds which keep the track under cover.

In speeding across British Columbia the train at Lytton enters the Fraser Gorge. Now and then the passenger catches sight of a river steamer, perhaps Indians are seen on the bank capturing salmon; and occasionally a "heathen Chinee" is observed busily engaged in gold washing. At last, after four days' journey, the train steams into Vancouver, the western terminus, whence there is a regular service of steamboats to Australasia and China and Japan.

A British statesman once described Canada as an "illimitable wilderness," and such it must have remained had not the Canadian Pacific Railway opened up the country, and afforded the prospect of bright and happy homes for millions of people. But the railway is also of great importance imperially, as it affords a new, quick, alternative route to the East, available for troops and munitions of war, which could be conveyed by it from the Mother Country to China and Japan quicker than by any other route; to Australia as rapidly as by way of the Suez Canal; and to India in a few days more. In view of the possible impairment of the Suez Canal in time of war, and of difficulties of coaling *via* the Cape, the importance of the Canadian route to the East is at once apparent.

When the Canadian Pacific Railway was proposed, it was urged in many quarters that the climate of the country alone was inimical to success. For periods of five years at a time the express from Montreal to the Pacific coast accomplishes its booked time or thereabouts; and it is even said that our own Great Western suffers more from interruption by snow than does the Canadian Pacific Railway. Nevertheless, the great-hearted men who fathered the enormous project were quite certain that the line would more than earn enough to pay for the grease for the axles of its wheels, which the pessimists said it would never accomplish. The conquering army of workmen pushed on, often laying two and a half miles of rail a day, with 1600 sleepers to the mile in some sections. And now the 2900 miles of main line form a brilliant link in Britain's "All-Red Route" round the globe. The Canadian Pacific Railway is the only real trans-continental line in the American continent; for the Union Pacific and the Southern Pacific lines in the United States cannot run from

PLATE C.

CANADIAN PACIFIC RAILWAY, THE IMPERIAL LIMITED MAIL, Locomotive No. 840, 4-6-0.
From Montreal to Vancouver, 2898 miles in 4 days 14 hours.

ocean to ocean upon their own metals, and the line from Buenos Ayres over the Andes is too short to compare with our great link in the north.

In addition to the ocean to ocean track, the Canadian Pacific Railway controls another 10,000 miles of line, and every day more than another mile is added; and on the immense system are nearly 1500 locomotives, 50,000 freight cars, and over 2000 passenger vehicles. It is estimated that if all the freight cars were loaded up at one time, the carrying capacity would be equivalent to the weight of the whole population of England.

The mileage of the trains totals up to 35 million miles; the freight trains carry 15 million tons; and the passengers number 10 millions annually. This last at first glance appears very small, but we must remember that the population of Canada is only 7 millions, and when a Canadian does travel, his average will exceed the 9½ miles, which about represents the Britisher's.

From the illustration (Coloured Plate C), we gain a very good idea of what the Canadian Pacific Railway locomotives are like. It is a fine sight to see the Montreal to Vancouver express by day steaming across the prairie, or forcing its way over the Rockies, but it pales into insignificance compared to the scene by night, when the engine search-light illuminates the track two hundred yards ahead. Many of the Canadian Pacific

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Railway locomotives are made in Great Britain, where sometimes orders for as many as thirty are on hand at one time.

The Cape to Cairo

"There! All British! That's my dream." So said Cecil Rhodes to a friend as he drew his finger from north to south down the map of Africa. The scoffers were soon busy pointing out the impossibility of such a harebrained scheme. Lay rails from the Cape to Cairo, forsooth! Rhodes might as well say that he would walk it. Well, that was just what a couple of young men on a holiday jaunt did do a few years later, and most heartily did Mr. Rhodes congratulate them upon their feat. He well knew that, wherever the human foot can go the iron-road practically ceases to be an impossibility.

There had long been a railway in the South of the Dark Continent, and presently it extended northwards as far as Vryburg.

A revolt in Egypt and the aspirations of the Mahdi caused Britain to occupy the Land of the Pharaohs; and General Gordon was at Khartum endeavouring to restore peace to the troubled land. After long preparations General Kitchener defeated the Mahdi—defeated him chiefly by means of a newly-constructed railroad, for certainly without that ribbon of iron the desert would have accounted for the British forces, even if the Mahdi did not do so. At Omdurman, on September 2, 1898, the Mahdi's host was scattered to the winds; the victory was too late to save Gordon, but Egypt would know peace. And Kitchener's military railway to Berber remained!

In the meantime, from Vryburg the southern railway had reached Buluwayo, where formerly was the head kraal, mealie patch and justice tree of the dusky potentate, Lobengula—and that was 1350 miles from Capetown. There was a pause of some years in northward progress, while Buluwayo was linked up with Beira on the east coast. In 1903, however, Buluwayo figuratively shook hands with the Wankie coalfield, 212 miles further towards the goal, and during the next year rail-head was at the Victoria Falls on the Zambesi river.

The Victoria Falls, first discovered by Livingstone, are about twice as broad, and two and a half times as high as the Niagara Falls, being over a mile wide, and 400 feet high—higher than the top of St. Paul's Cathedral. The level of the land above the falls is the same as that below, the immense volume of water falling precipitately its entire breadth into a deep narrow fissure over a mile in length.

"There is only one small outlet, about a hundred yards wide, to this awful chasm, and the roar and turmoil—a veritable and mighty troubling of the waters—where the seething mass thunders through this opening into what has been fitly named the Boiling Pot, is terrific and bewildering. From the Boiling Pot the contents of the Zambesi River rush with unbridled fury along a narrow and deep gorge of basaltic cliffs, which extends with many zig-zag windings for over forty miles."

As no staging could be erected in the boiling flood, the cañon could only be bridged by erecting from the opposite sides the two halves of the arch for them to meet in the middle. Across the gorge was fired a rocket with a cord attached; a wire followed, which was replaced by a rope and a temporary carrier on which the working wire cable was conveyed. By means of this cable, a locomotive and tender and 2000 tons of bridge materials were transported over the boiling pit, and the construction of the Victoria Bridge commenced.

Six months saw the completion of the highest bridge in the world, a feat of which British engineers have every reason to be proud. The railway then quickly reached Broken Hill, over 2000 miles from Capetown, and only about a hundred from the Congo Free State; for, unlike the Canadian Pacific railway, the trans-continental African line cannot be "All British."

One looks at what has been accomplished; one remembers what has been done in the past by the Briton's mechanical genius, his zeal in trade and commerce, and his belief that to assist in the betterment of mankind is a sacred duty. Who shall say that Cecil Rhodes was a dreamer!

Siberian Railway

It was in 1854 that two Scots applied to the Russian Government for permission to survey Siberia with a view to the construction of a railway. The idea bore fruit. For nearly half a century Russian statesmen dreamt about it—and then, one day, the work was commenced without the assistance of the Scots.

Bringing St. Petersburg into direct railway communication with Vladivostok, 7680 miles away, was an enormous project well calculated to attract world-wide attention. It was already possible to reach Cheliabinsk on the eastern slope of the Urals by rail, so that the new line necessitated 4740 miles of metals.

Omsk (493 miles) welcomed rail-head in 1895, and the river Obi smiled upon it in 1896; and by the middle of 1899 the line was open as far as Irkutsk, a total distance of 2000 miles. Work, too, was proceeding at the other end, and the section from Vladivostok to Khabarovsk was completed. By that time it was decided to change a section of the route; it was not to be "All Russian" as originally intended; it would cross Manchuria, Chinese territory, and reach Vladivostok *via* Harbin, with a branch line to Port Arthur. The engineers welcomed the alteration, for it meant the avoidance of a tortuous and terribly tedious section that would have run parallel with the river Amur. The line was at length completed at a cost of about £100,000,000.

The construction of the Siberian line is not to be compared to the Canadian Pacific Railway, for the former was laid at a rate of about a mile a day, or less than half the speed of the Canadian. Yet the Russian work was flimsy in the extreme; there were no chairs, rails simply bolted to the sleepers, and there were no fish plates. The line was certainly not built for speed, for anything over six or seven miles an hour would tear the light rails from the sleepers. Nevertheless, the new route to the East rendered Russia good service during the war with Japan, although it could not save "All the Russias" from terrible humiliation at the hands of the Japanese in the siege and fall of Port Arthur.

Siberia was once known as "the cesspool of Russia," and the very word suggests to us "exiles consigned to living death" in a bleak and inhospitable land almost as pitiless as the grave. Southern Siberia, however, is not so black as it was formerly painted; true the mercury freezes in winter, but it is equally true that "in summer the soil burns the foot." At any rate, Steam again proved to be the beneficent giant he ever was; Southern Siberia began to find that life was worth living; and there commenced a brisk trade in cattle, grain, butter and eggs.

To take a wider outlook, the Siberian railway knits the world closer together. Jules Verne, with a riotous imagination, wrote *Round the World in Eighty Days.* He did not take this new railway into consideration, or he would certainly have halved the time. Thanks to this iron-road across Asia, it is now possible to travel round the globe in about thirty-three days.

CHAPTER XI

LINES HERE AND THERE

RAILWAYS are ubiquitous; they bob up in all kinds of unexpected places, and sometimes they are very queer railways, too. In only half the pages of this book it is manifestly impossible to pretend to describe all the different kinds of railways in the world. But upon examination and analysis, we arrive at the conclusion that they resolve themselves into only a few distinct kinds; and are much fewer in type than are the actual locomotives that run upon them.

Uganda Railway

This East African line is included in our review, not that there is anything peculiar in its track or rolling stock; but chiefly because of the very unusual difficulties encountered during the progress of the work of construction.

Uganda was described by Sir H. M. Stanley as the "Pearl of Africa," and he knew too much of the Dark Continent easily to make a mistake.

In 1875 Mtesa was King of Uganda, and he requested Stanley to send missionaries to his country—an invitation that the Church Missionary Society very speedily accepted. The famous explorer considered the Baganda the finest people in Africa, and took the greatest interest in them until his death; and some of his last dying messages were for his dusky friends, who look upon the great traveller as one of the greatest benefactors of their country.

The explorer and the missionary were in British East Africa long before the railway. It was not until 1875 that a line was commenced from Mombasa, on the coast, to the shore of Victoria Nyanza. Two years later the metals reached Tsavo, only a hundred miles inland. Scarcely ever did railway builders meet with such disappointments as here waited upon them. The work was estimated to require £3,000,000, and that sum was voted for the purpose by the British Government. By the time the money was spent not half of the line was completed, and much that had been done already required renewal. White ants attacked the wooden sleepers and reduced them to mere shells, and steel sleepers had to replace them; and the water of the region was impregnated with salt that corroded the boilers and spoilt them. Thousands of coolies were imported from India to work on the railway. Many, stricken by fever, lack of water, and the attacks of wild animals, left their bones to bleach under the Equatorial sun.

At Tsavo, in particular, the attacks of lions suspended the work for several weeks. In a very short time the native navvy staff was short of twenty-eight Hindoo coolies and still more African natives. So bold were the marauders that they snatched men from around the camp fires and dragged others out of their beds in the tents.

The coolies, filled with inherent superstition concerning the transmigration of souls, believed that the lions were the spirits of dead and gone African chiefs, who thus showed their dislike to the white man's iron-road. They struck work, and one could scarcely wonder at it. Navvying under the Equatorial sun was sufficiently hard in itself, without the mind being constantly on the rack, wondering whose turn it was to supply a man-eater with its next meal.

Fortunately, Colonel Patterson, an experienced hunter, came to the rescue, and after a great deal of trouble he accounted for the couple of cunning beasts, who had interfered with the work of Empire-building. Though the coolies had proved absolutely helpless in the crisis, they keenly appreciated the colonel's prowess; and they presented him with a fine silver bowl in token of their gratitude.

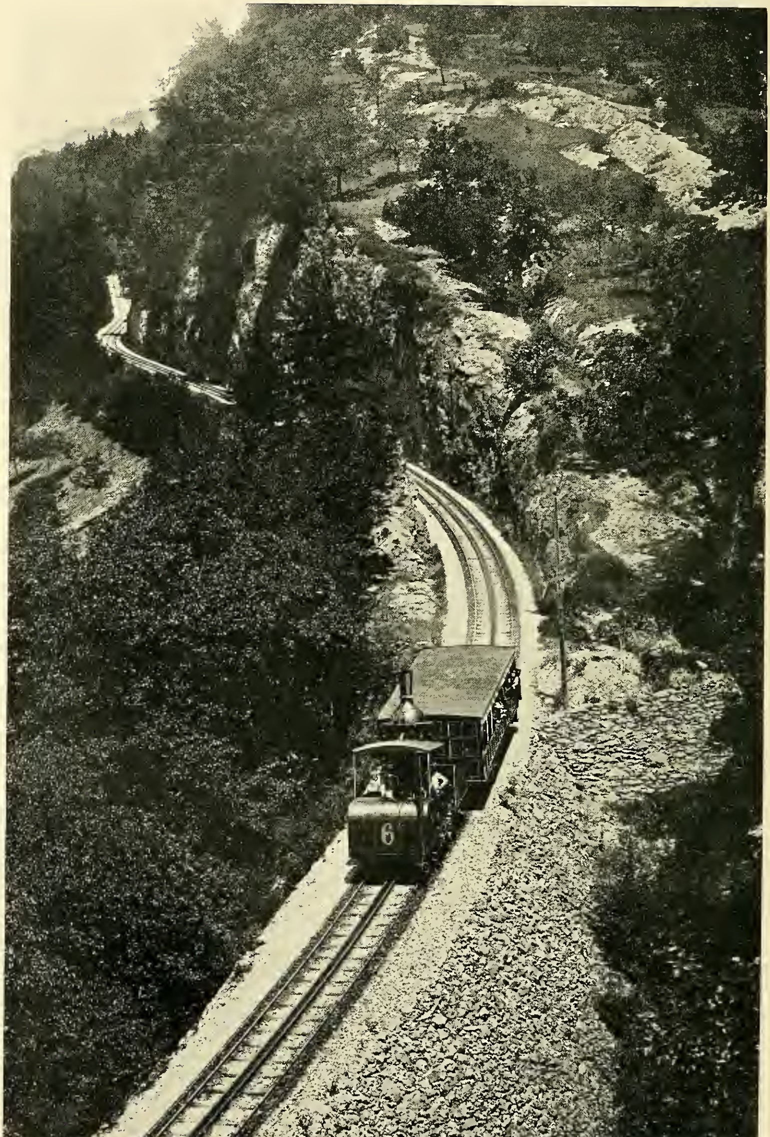


PLATE XXVI.

RIGI RAILWAY.

The Uganda railway has long been an accomplished fact. From the coast the bright rails go streaking into a region, at one time quite as benighted as where David Livingstone laid down his life in his unwearied effort "to evangelize the native races, to explore the undiscovered secrets, to abolish the desolating slave-trade of Central Africa."

In the whole of the world there is scarcely to be found a more promising field for mission work than in Uganda. The climate of the country, thanks to its elevation, is healthy, although warm enough to produce coffee, sugar, maize, rice, bananas, etc. The Baganda are under the British Flag, and very many of them are already enlisted in the service of the Great Captain of all.

Conquering the Alps

European railways, as a whole, very much resemble our own ; and when once we have crossed the Channel to Flushing, Ostend, Calais, or Boulogne, we can find excellent services to the capitals of Europe, as far apart as Amsterdam, St. Petersburg and Constantinople.

In all railroad engineering there is perhaps nothing to surpass the manner in which man has burrowed under and through the Alps in order to effect short cuts from one country to another.

Mount Cenis Tunnel was completed in 1871, after thirteen years' labour, the cost working out at about £220 a yard. This tunnel quickened the service of the Anglo-Indian Mail from Calais to Brindisi *via* Paris, Mount Cenis and Turin.

St. Gothard Tunnel took nine years to complete. It is two miles longer than the last named, and cost less than £150 a yard. Time and money were saved by the invention of the rock drill. Nature was not conquered without a bitter struggle, for the operations involved the deaths of the contractor, chief engineer, and six hundred workmen. The opening of the tunnel gave Germany better access to Italy *via* the Swiss railways.

The Simplon Tunnel entailed boring for twelve miles through a mountain mass, 7000 feet below its crest. It was known that some of the strata were of a very treacherous nature and that there was danger from both hot and cold springs, yet the engineers were not daunted. The heat in the workings necessitated the men being sprayed with water while they drilled and blasted and hewed. Only after a titanic struggle did Nature submit; eighty men laid down their lives in the contest. This gigantic undertaking cost £133 a yard. It brought London and Milan into closer touch by 70 miles—and the railway engineer will attempt a very great deal to save a tenth of that distance.

Mountain Railways

The railway proved itself to be a real mountain climber when the C.P.R. Company crossed over the Rockies by means of the same permanent way and rolling-stock that it used on the flat prairies. To climb the Alps is easier than to pierce through them, though from the point of real usefulness there is no comparison. An Alpine mountain railway is chiefly to afford pleasure to tourists; to show them the magnificent scenery only to be found at lofty altitudes, without the arduous exertion entailed in mountaineering proper. There are more than half a dozen Alpine heights already conquered by the metal ribbons, and a description of the ascent of one of them must serve for all those in the Playground of Europe.

The Rigi is an isolated mountain mass overlooking the lakes of Lucerne and Zug, and thanks to it not being shouldered by other imposing heights, it commands an extensive panorama, to view which 10,000 tourists annually consider it worth while to make the ascent.

On any Swiss mountain it would be impossible to limit one's self to gradients of 1 in 300, which George Stephenson considered the reasonable limit. The line in places seems to cling to the mountain side, snakes along the edges of rather terrifying precipices, mocks threatening landslips, and in various ways flouts Dame Nature in what she used to consider was her very own fastness.

And an engine and carriages do these unrailway-like things on a railed track? Yes, only the engineer fits his track and vehicles to the very special conditions which the mountain service entails. The line is on the rack and pinion principle. Between the two rails proper are laid two others, connected by cross-bars, on which works a cog-wheel under the engine. The carriages are pushed up to the summit, not drawn, so that there is never any fear of the load breaking away from its couplings, the result of which would be appalling. The journey up the Rigi is an interesting experience, and at its conclusion the tourist is well repaid for the fare expended—not trouble, for this armchair mountaineering does not entail any.

Snowdon Mountain Railway

In our own country we have a reduced facsimile of the Swiss mountain railways. From Llanberis is a rack-driven railway to the summit of Snowdon, which is reached by $4\frac{3}{4}$ miles of track, 2 feet $7\frac{1}{2}$ inches gauge, with gradients as steep as 1 in 5. The rack is different from that employed on the Rigi. In this case two parallel toothed rails are laid close to each other, and arranged so that their teeth are not opposite to each other, and thus the cogs of the engine-pinions firmly grip the rack, and impart little or no vibration to the load. This rack arrangement is in common use all over the world. The fare from the base to the summit of Snowdon is 3*s.* 6*d.*; 5*s.* return. The locomotive is 150 h.p., and quite easily it pushes before it two carriages accommodating sixty persons.

All the way up, there are splendid changing views, of which the best is looking down 2000 feet into the Pass of Llanberis, with the cone of Moel Siabod keeping guard. The summit station is only a few yards from the highest point of the mountain, from which is obtained a long distance view, including Holyhead Mountain, Britannia Tubular Bridge, and Pwllheli.

Welsh "Toy" Railway

The Festiniog Railway, better known as the "Toy," was originally built for the rather prosaic purpose of transporting slate from the Festiniog quarries to Portmadoc. The waggons descended the line by gravitation, and the empties were hauled back by horses.

When it was proposed to utilize the line for passenger traffic, it was thought that the curves on the line, in its accommodation to the mountain slopes, would not allow of steam traction. We know what a leading bogie does for an ordinary express locomotive, and bogies back and front on both engine and carriages solved all difficulties on the "Toy." An old railway driver, in explaining the usefulness of the bogie, said that it "bent like a whip," which makes one think that he must have driven a "Toy" engine; for the most outrageous curves are swung round almost as if they did not exist. The gauge of the line is only 1 foot 11½ inches, and of course the engine and carriages are in proportion. The Festiniog railway not only serves local needs all the year round, but in summer is very popular with holiday excursionists, who in most cases prefer to ride in the open slate waggons.

Liverpool Overhead Railway

In dealing with American railways we mentioned the necessity for various companies elevating their lines to remove perils from the streets; and the matter was left in order that our own Liverpool Overhead Railway might afford effective illustration. Elevated railroads had their birth in New York. Most of our readers are familiar with the laying of a tram-line in the streets of a town, but in the case of the "Overhead," the line is laid upon a continuous platform that is supported by pillars and piers. Thus the railway traffic can

PLATE XXVII.

LIVERPOOL OVERHEAD RAILWAY.

TUNNELLING A LONDON TUBE RAILWAY.

go on up above without any interference with the street traffic below, more than is caused by the supports. The illustration will serve better than any further description.

The Liverpool Overhead Railway (Plate XXVII), which is double-tracked, stretches along the river frontage by the side of the docks for $6\frac{3}{4}$ miles, starting at one of the northern docks and terminating at the neighbouring borough of Bootle. The line, which is worked electrically, was opened in March, 1893.

London Tube Railways

A tube railway relieves congestion of the streets in a manner altogether different from that of the overhead railway, namely, by burrowing underground, so that it is nothing less than a continuous tunnel. Underneath London is a network of tube railways, forming a subterranean world with over fifty miles of line, stations, signals, and the thousand and one contrivances to ensure safe and speedy transport of millions of passengers during the year. The lines and stations are at as great a depth as 200 feet (Plate XXVII), and passengers descend to the lines or ascend again to the streets by means of lifts working in shafts. It is electric traction that has made railway tubes practicable; ordinary steam locomotives would render the air altogether too foul for passengers to endure at such a depth except for very short distances. The Metropolitan and District Railways, with over sixty miles of line, were in existence before the advent of electricity, and though only a few feet below the streets, and the tunnels constantly broken by stretches of open track, the sulphurous atmosphere was a sore trial to those persons who were forced to use these earlier underground railways. The advent of the electrical motor brought reformation in its wake, for the Metropolitan and District Railways adopted electric traction, and the last steam train running on the Inner Circle was withdrawn on September 22, 1905.

Electricity and the petrol engine are destined to work great changes in the railway world, and to make serious inroads upon the supremacy of the giant Steam. In the United States, in particular, electrical traction has made enormous progress, as shown by over two hundred tracks, none of which are less than 50 miles in length—there are many others that cover shorter distances—and New York and Boston are joined by an electric track, over 180 miles in length.

In England there are yet only about 200 miles of railway track worked by electricity, but additions are being constantly made; and the conversion of some of the steam tracks is only a matter of time, largely governed by the question of the initial expense of relaying the lines.

A much discussed method of locomotion is the mono-rail system, which, as suggested by its title, consists of a single elevated rail, upon which the engine and carriages hang pannier or saddle-fashion, equal portions on each side. At the Brussels Exhibition in 1897, upon an experimental track, seven miles long, an electrically driven car attained a speed of 90 miles an hour with ease and safety. Parliamentary powers have been obtained for connecting Liverpool and Manchester by means of a line of this kind. Steam express passenger trains cover the 34½ miles in 45 minutes, but when the mono-rail becomes an accomplished fact, the two cities will be brought within less than half an hour of each other. It must not be imagined that the mono-rail is a fantastical project with problematical possibilities, for a mono-rail has been in existence in Ireland between Listowel and Ballybunion (9 miles) since 1888. In this case, however, the motive power is steam, and not electricity.

CHAPTER XII

ALL CHANGE!

YOU have heard that cry many times. You have seen a train draw up at a platform, and have heard the porters calling out the name of the station, followed by the injunction, "All Change!" That is just the stage at which we have arrived in this volume. We are about to change; not from one compartment to another, or even from one railway system to another; we propose to continue our journey by an altogether different method of progression. We are exchanging the iron road, that often costs immense sums per yard, for Nature's own world-wide path that is free to all, that costs nothing to repair; if its whims and fits of contrariety would not sometimes develop into very bad tempers, it would be a road that was just perfection.

All change! Out swarm the passengers on to the platform. All change! Into this chapter, almost haphazard, fall all kinds of odds and ends that will round off our numerous railway excursions here and there on the face of the globe.

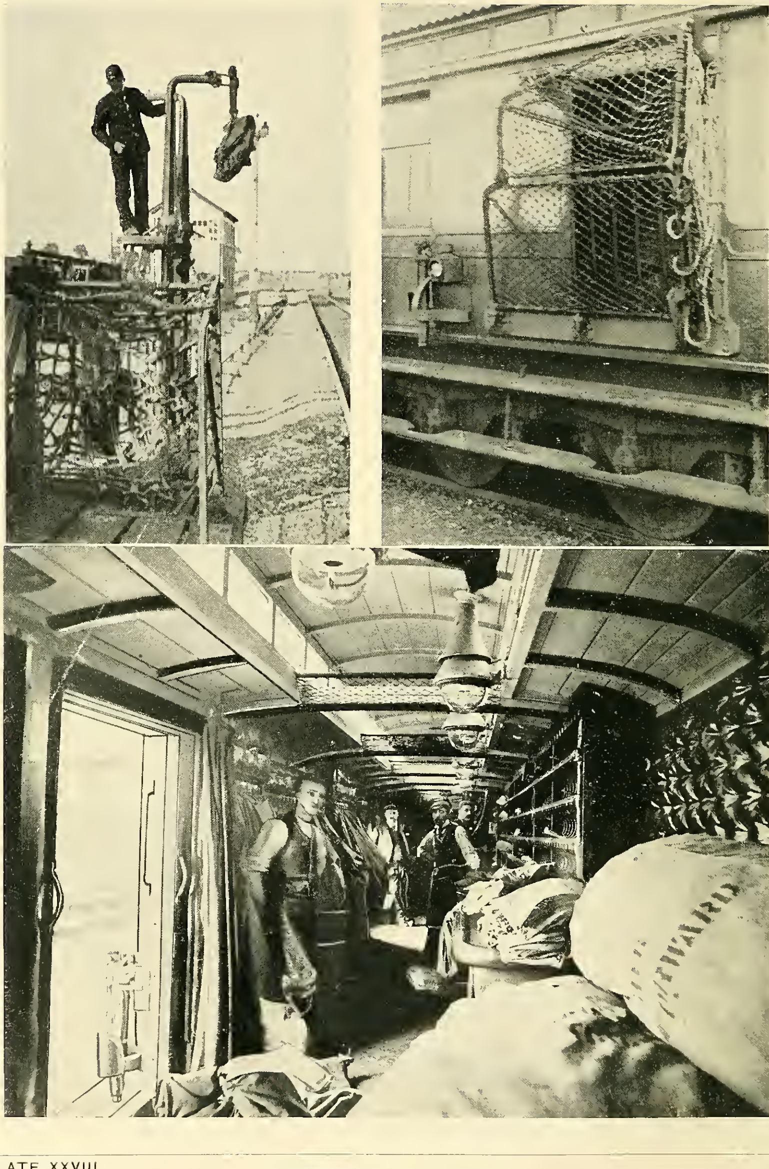


PLATE XXVIII.

CATCHING THE MAILS.

1. SUSPENDED MAIL BAG. 2. THE CATCHER. 3. INTERIOR OF SORTING VAN.

One of the greatest blessings of modern life is the penny post. Facility of intercourse promotes orderly and kindly fellowship between man and man, and assists the moral and intellectual progress of the nation. The locomotive has given both speed and cheapness to our postal services, since the mails were first carried by Act of Parliament in 1838.

For a moment we will watch the sorting operations at the General Post Office. When the stamps have been obliterated the letters are sorted into what are called railway divisions to suit the various railway routes; thus a letter for Carlisle will go West Coast, while one for Newcastle-on-Tyne will go to the Great Northern for the East Coast route.

Attached to the mail train is the sorting tender or travelling post-office, with a staff of sorters, who work while the train is travelling at from 50 to 60 miles an hour. The letters are rapidly sorted into "roads," all those for the towns and villages on a certain length of line being put in one sack, which is thrown out at its proper station as the train passes through it. One can guess at what speed the sorting is accomplished; it must be completed to the minute, or the letters for any particular road will not reach their destination in time for the first delivery.

In addition to the load with which the mail van commences the journey, letters are also taken up en route, even while the train is in rapid motion. The letter-bag is suspended from an arm extending from a post by the side of the rails; and as the mail train approaches it, a net apparatus, affixed to the sorting van, opens wide and sweeps the bag into the van (Plate XXVIII).

Cheap tickets and popular excursions to favourite resorts are a special feature of modern travelling. Probably the Midland was the first company to run an excursion train; the occasion was Leicester Exhibition in 1840. The train from Nottingham consisted of seventy carriages, which held 2400 passengers, and the enormous weight reduced the speed almost to that of a funeral procession. The train arrived at its destination, which would have been doubtful if it had been divided, for the signalling arrangements then in vogue were not calculated to cope with any congestion of traffic. Nowadays, railway companies deal expeditiously with enormous crowds of excursionists. Upon one Saturday morning in April it is nothing unusual for the L. & N.W., Great Northern, Midland and Great Western between them, to run over a hundred excursion trains into London, in connection with the English Football Cup Final; and still others come from various points of the compass. From Burton one great works' annual holiday trip calls for about a score of excursion trains all bound for the same destination. If, for example, it be Blackpool, 90 miles away, the first train will arrive there about the time that the last is leaving Burton station.

Bank Holiday traffic is always a rare test of railway organization. The London and South-Western upon one such day will despatch over a thousand excursion trains; and at Waterloo and Paddington stations alone, as many as 8000 bicycles will need to be stowed in the luggage vans.

With our passenger trains running 264 million miles in the year, and carrying 1278 million passengers, exclusive of season-ticket holders, it is scarcely to be expected that such enormous movements could be effected without accident, whatever precautions are taken; but if for no other reason than that a serious accident to a train may involve a company in a loss of £100,000, every effort is made to minimize the risks of railway travelling. First, we will deal with accidents to passenger trains. In 1879 occurred the Tay Bridge disaster, when 73 lives were lost; and for that year the proportion of passengers killed to the number carried was 1 in 7½ millions. In 1889, the year of the Armagh collision, when 80 persons were killed, the proportion was 1 in 8 millions. In the two years, 1901 and 1908, not a single passenger was killed; and for the eight years, 1901-1908, the proportion of passengers killed to those carried was 1 in 70 millions. If we include season-ticket holders, of whom there are hundreds of thousands, making at least two journeys to and from business daily, the figures would bear a still more favourable aspect.

Accidents to trains resulting in injuries to passengers vary considerably in different years; for example, in 1901, when no passenger was killed, the proportion of injured to those carried was 1 in about $2\frac{1}{2}$ millions, but in 1908 it was 1 in $4\frac{1}{2}$ millions.

There is death on the line, however, apart from accidents to passenger trains; sometimes in a single year 400 persons, chiefly trespassers, are run over. Railway servants, too, are very liable to accidents; three or four hundred are killed annually, and over four thousand are injured; permanent-way men, labourers, shunters, and porters, are the chief sufferers.

British companies may fairly claim that, in addition to speed and comfort in railway travelling, they provide the greatest possible safety that human thought can compass. We may smile at Mark Twain's statement that a railway train is safer than a bed, since so many people die in the latter; but it is a fact that life in our railway trains is safer than in the streets of a big city; and Sir Watkyn Wynne once asserted in public, that in the British Isles in the course of a year more people choke themselves than are killed in accidents to passenger trains.

But danger lurks on the iron road in many unsuspected forms. George Stephenson said, it would be "bad for the coo" that met one of his engines. At Ilkeston on December 4, 1906, a cow took fright when being driven along the streets. It dashed into the railway goods yard, where it was knocked down by a shunting engine attached to several waggons. The impact derailed the waggons and blocked the line for several hours.

Something to cause an accident sometimes seems to spring up from nowhere, and no human power can avert the danger in the infinitesimal fraction of time, which is all that is allowed to the busy train and the frantic hands of the most cool-headed driver. Frozen brakes have caused a train to get out of control; the wind has blown trucks out of a siding into the way of an express; the expansion of the rails has caused trains to be derailed; and a trolley has rolled off a platform on to the metals just as an express hurtled through a station. Plate XXIX illustrates the wholesale destruction that sometimes attends an accident.

Of all the accidents on British lines, one that occurred on the Great Western in the early days was certainly not the least remarkable. On June 17, 1845, the down express was fifteen miles from Paddington when the wheels of the luggage van left the rails on the south side; but the longitudinal sleepers kept the wheels close to the metals, so that the officials were unaware of the danger. The train ran for a mile and a half with the van off the line until it crossed a bridge, where the rails were laid differently. The engine, tender, three passenger coaches and van were thrown off the line and hurled down an embankment; and yet the 130 passengers escaped with nothing worse than a few bruises and a severe shaking.

On a line in Mexico a driver drew up his train when he saw a red lamp ahead, with the result that presently another train crashed into the rear and caused a very great deal of damage. The red lamp turned out to be strictly unofficial; a swarm of cochineal insects had changed a plain light into one of a vivid crimson.

Exactly such an accident could not occur in our country, if only because of the absence of cochineal insects; but a spider stopped a train on the Midland Great Western line in Ireland on June 4, 1908. The signalling between Ballyhaise Junction and Belturbet is worked by means of an electrical apparatus, and a spider getting into the instrument between the contact points and the key lever caused a disconnection. No accident resulted, but the train was delayed for nearly a couple of hours.

The history of our railways teems with thousands of interesting incidents, of which the

PLATE XXIX.

A RAILWAY SMASH.

difficulty is to make a selection. At Camden Town goods station a night-watchman saw a dimly outlined figure skulking in the shadows. The man was instantly on the *qui vive*; and slowly and stealthily he dogged the intruder, until in a dark corner he was able to pounce upon the assumed burglar. A moment later he was one of the most amazed men in London, for he had clasped not a man but a brown bear, which had escaped from confinement.

Upon the same line occurred an incident with all the possibilities of tragedy to follow. From a goods waggon a crate fell on to the line, the concussion setting free its inmate, a fine Bengal tiger. The animal speedily disappeared round a bend in the line; and a little later a party of soldiers from some neighbouring barracks was sent off in pursuit. They found the tiger in the neighbourhood of a signal-box. The signalman happened to be outside the cabin when the animal appeared; and being quite certain that the L. & N.W. instructions to signalmen made no reference to tigers, he promptly decided to take no risks and climbed a telegraph pole. When the soldiers appeared upon the scene it occurred to them that they were without ammunition; but, in the meantime, a local sportsman appeared and shot the unusual trespasser on the line.

We often read of persons being prosecuted for attempting to avoid payment of railway fares. In January, 1877, proceedings were taken against half a dozen children for fraud, and the evidence read more like romance than solid fact. The children were playing in the goods station yard at Plymouth, where they hid in a truck to avoid the notice of an official. Whilst waiting for an opportunity to steal away unobserved, they fell asleep, and when they woke up they were in the goods yard at Truro en route for Penzance.

Scared out of their wits, the youngsters got down to the ground with the intention of walking back home, little dreaming that Plymouth was fifty miles away. It commenced to rain heavily, and they sought shelter in another truck, where they again fell asleep and were taken to Bristol. When they were discovered they were not only sadly bewildered, but almost exhausted from lack of food. Meanwhile, at Plymouth, there was considerable stir; it seemed incredible that half a dozen children could disappear so completely. It was not until the second day that a police telegram from Bristol brought relief to the sorrowing parents, who, in due course, received back their erring offspring. The railway company only prosecuted the juveniles for the sake of example, but the magistrates dismissed the delinquents, holding that their offence was trespass rather than fraud with which they were charged.

PLATE XXX.

L. & S.W.R. COLLECTING DOG, "WIMBLEDON NELL."

ORPHAN GIRLS, L. & S.W.R. ORPHANAGE, WOKING.

In the course of what is only a brief and chatty review of our British railways, together with a few in other parts of the world, chiefly for comparison, we have touched upon many interesting phases of what is a great national industry. Wherever we travel on our iron roads we cannot fail to be struck with the never-ceasing efforts of the railway workers, from the highest to the lowest, to further the comfort and safety of the passengers—efforts, alas! that for not a few of them entail maiming and even death. Railway Orphanages should unfailingly enlist our interest and support. On many of our railway systems are collecting dogs (Plate XXX), that travel from station to station, gathering the contributions that should not be viewed as charity, but as a duty which travellers owe as estimable and self-sacrificing body of men as can be found in the service of the public.

STEAMSHIPS

PLATE D.

CUNARD LINE R.M.S. "MAURETANIA" AT ST. GEORGE'S LANDING STAGE, LIVERPOOL.

CHAPTER XIII

THE SAILORS OF OLD TIME

WHO was the first navigator? The question may go ringing down through uncountable ages before the dawn of history, and there will be no answer. The earliest craft were doubtless the trunks of trees or logs of wood upon which primeval man trusted himself for a journey down a stream. The use of flint tools and the discovery of fire would lead to the trunk being laboriously chipped or burnt out to form a rude canoe. This at the best could serve its purpose only upon one particular stream, and would be of little use to nomadic man, who wandered about the country, changing his location according to the season and the food supply. The savage would require a boat that could be transported easily from stream to stream; and thus, in course of time, he constructed a canoe of bark, or skin stretched over a framework of wood or plaited reeds.

Coming to Biblical history, Noah was the first shipbuilder of whom we have any record. The ark is supposed to have been 450 feet in length, 75 feet in breadth and 45 feet in depth, and it was pitched within and without. Fragmentary as our knowledge is, this at least showed a great advance upon the dug-out trunk or the canoe of wicker-work and skin.

Shipbuilding, however, is easily traced to the Egyptians; Darius brought away a galley from that country in the year 1485 B.C.; but there are carvings twice as old that depict ships propelled by many oars and capable of carrying many men or considerable cargoes. Reference may be made to the mercantile navy of the Phœnicians, though we have no means of verifying the statement of Herodotus that these old-time mariners rounded the Cape of Good Hope.

St. Paul affords us considerable information concerning the vessel in which he voyaged to Rome. It had sails, anchors and a rudder; the sailors took soundings to ascertain their nearness to land; and the size of the vessel is indicated by the fact that there were 276 souls aboard, in addition to a cargo of wheat. The ship also carried a boat, for, when danger threatened, the sailors proposed to leave the passengers to shift for themselves. Altogether we learn that the shipbuilder of these early times had long passed the elementary stage of his business.

The Carthaginians were noted shipbuilders. In the year 500 B.C. Hanno sailed out of the Mediterranean, rounded the north-west shoulder of Africa and reached as far south as the Gulf of Guinea. The chief feature of his voyage appears to have been the discovery of certain strange "hairy people." English boys and girls are just as interested to-day in the chimpanzees at the Zoo, as was old Hanno when he encountered them for the first time in their native home.

An ancient Greek or Roman war vessel was the highest effort of the shipwright in those days. It was generally one-masted and carried one huge square sail; but often as many as 300 rowers, sitting in ranks one above the other, plied long oars to assist in propelling the vessel, especially against the wind. A portion of the deck was raised above the bulwarks, upon which were fixed various engines for hurling stones and darts. Vessels engaged at close quarters, and grappling irons were used with which to hold on to the enemy while it was boarded. One notable feature of a war vessel was its beak of pointed iron with which to pierce the timbers of an opposing craft; and on the prow was generally painted a pair of eyes, as though the vessel were a living being capable of seeing for itself.

Some writers maintain that the ancient Britons possessed craft in which they traded with the Continent; but in any case British boats were incapable of offering resistance to Julius Cæsar's fleet of eighty ships, which conveyed a force of 12,000 men to our shores in the year 55 B.C.

The Romans occupied Britain until A.D. 410, but before that time the eastern coast had been harried by the Saxons—blue-eyed, flaxen-haired sea-rovers who revelled in fighting and storm, and who quickly laid their yoke on the Britons, when the Romans were no longer in the island to protect them. Four centuries later the Vikings, with their blood-red banner on which was depicted a fear-inspiring black raven, were pillaging the coast with a ferocity greater even than that shown by the Saxons.

Alfred, the Saxon king, built a fleet of vessels stronger and swifter than any hitherto known, and with these first British warships he routed seven Danish craft in Swanage Bay in 875. This was our first naval victory, the forerunner of an amazing series of successes such as no other nation can boast.

The people of Britain, thanks to their absorption of so many North Sea rovers, became noted for their seamanship, and the fishermen of the south-east coast, in particular, in times of danger formed a naval force for the defence of the island. In 1066 a number of vessels gathered together for the purpose of preventing an invasion by the Normans, but as Duke William delayed his coming, the vessels dispersed to Hastings, Sandwich, Romney, Hythe and Dover, because the crews were required on land to work in the harvest fields. This was the Duke's opportunity, and with a thousand craft of different kinds he landed 15,000 men, horses and military stores upon our shores, and soon afterwards put the seal upon his purpose at the battle of Hastings.

A little over a hundred years later Richard I. set out for the Crusades; and a British fleet for the first time in history left the home waters for the furthermost end of the Mediterranean Sea, joining with other nations in the attempt to wrest the Holy Land from the Turks. The vessels were chiefly only 20 tons burden, and they still had but one mast and one big square sail; but the hearts of the men were as stout as the timbers of the little ships that carried them over 3000 miles from home. Edward III. invaded France, and for a hundred years on land and sea the two nations strove for the mastery. This rivalry led to continual improvements in warships, which were always duly reflected in the mercantile vessels.

Towards the end of the 15th century European seamen were afflicted with a perfect fever of exploration and discovery. Bartholomew Diaz, a Portuguese, set the fashion with a passage to the

Cape in 1487, a tremendous undertaking for those days, although we know that the navigator kept in sight of the coast to the end of the voyage. Christopher Columbus dared still more. With three small ships he set sail across the Atlantic Ocean—the "Sea of Darkness" as it was called. In this case there was no coast to hug, and only by entreaties and threats did the fearless navigator persuade his superstitious crews to hold on the voyage long enough to stumble into the New World.

Six years later (1498), Vasco de Gama, emulating his countryman, Diaz, not only reached the Cape, but he rounded it and proceeded to Calicut, in India. Early in the next century Magellan, another Portuguese, set out on a voyage round the world, and though he perished in the Pacific, one of his ships returned home, the first to have circumnavigated the globe.

British seamen were not idle in these stirring times. In 1497 John and Sebastian Cabot sailed from Bristol and discovered Newfoundland, our oldest colony; and Henry VII. awarded the navigators the sum of ten pounds, an amount that nowadays is frequently offered for the recovery of a lost dog. A few years later Richard Chancellor entered the White Sea and from thence journeyed overland to interview the Czar of Russia. In 1576 Martin Frobisher was attempting to discover the

North-West passage; and in the meantime John Hawkins, Francis Drake, Walter Raleigh and other daring sea-dogs scorned the terrors of the Atlantic Ocean; and competed with Spain for a share in the riches of the New World. Dutch navigators, too, were busy, but chiefly in the East.

When Francis Drake first saw the Pacific from a mountain height in Panama, he was overcome with emotion. Straightway on his knees he fell, and prayed God to give him "life and leave once to sail an English ship" upon the mysterious expanse of water, which he had hitherto believed to be a myth, a fairy tale of romancing voyagers. Four years later, with four small vessels, Drake left Plymouth to fulfil the dream of his life. Rounding Cape Horn, he sailed along the American coast until he reached California, where he erected a post bearing the name of Queen Elizabeth in letters of brass, betokening that he had taken possession of the country for his beloved mistress. From thence he sailed to the East Indies, and then *viâ* the Cape of Good Hope he re-entered the Atlantic and reached Plymouth in safety, with the proud distinction of being the first Englishman to sail round the world. "The Golden Hind," Drake's biggest vessel, was only a hundred tons, while one of the quartette was six times less. No wonder Queen Bess commanded the weather-worn, battered "Golden Hind" to be brought to Deptford, where she inspected the famous craft and knighted the bold seaman, who had added such lustre to Britain's shipping.

For many years our seamen's thoughts were concerned with the West, but upon one occasion Drake rifled a Spanish ship, the "San Felipe," that had come from the East Indies. The papers on board showed that the Eastern world possessed as many riches, if not more, than the Western. Soon there arose the East India Company to establish trading factories at Surat, Bombay, Madras and Calcutta, which formed the foundation of our rule in India, and eventually secured for us "the brightest jewel in the British crown."

Let us take stock of the British Empire in the year 1768. In the New World, in addition to possessing Newfoundland, Wolfe added Canada by a victory over the French at Quebec; the Pilgrim Fathers had founded the New England States, afterwards to expand into the United States of America; and in the West Indies various islands acknowledged the British crown. In Asia, at the battle of Plassy, Clive practically won India, for which the Western nations had long contended with each other; and in Africa we had secured a footing on the West Coast. By far the greater portion of "Britain beyond the Seas" had been gained by force of arms, but now the adventurous navigator, pure and simple, was to add a whole continent to our possessions without the shedding of blood or the loss of a single life.

The Dutch were the first Europeans to locate Australia, and Tasman was bent upon exploring it, when in 1642 he alighted upon New Zealand instead. Our own Captain Dampier, in his ten years' voyage round the world, actually landed in New Holland, but left it to Captain Cook to find his way to Botany Bay, and take possession of Australia in the name of George III.

Captain Cook was one of the most famous navigators the world has ever known; but in his remarkable voyages he enjoyed several advantages that were denied to Drake, Cavendish and Dampier, in whose track he followed. The earlier navigators literally groped their way across the oceans, ascertaining their position only by very uncertain, crude, rule-of-thumb methods. Halley, the astronomer, invented the sextant by which to take the elevation of the sun accurately; and John Harrison produced a chronometer, or ship's clock, to tell the difference between the time where the vessel was situated and the point from which it had set out. To settle latitude and longitude was no longer an embarrassing problem, and Cook took full advantage of the new aids to navigation, and kept accurate records of his voyagings, that proved of immense service to later navigators.

During the passage of the centuries sea-going vessels had increased in size and in the number of sails, with a still greater improvement in general efficiency. The mariner was now able to find his way across trackless wastes of water, by day or night, with less probability of being lost than if he were traversing London's maze of streets. Nevertheless, there was no real change in the principles of propulsion.

But a new departure was coming. Ships were no longer to be dependent solely upon wind and wave—the marine engineer was seeking to make friends with the Giant steam; and in water transport was to be worked a revolution that amounted to little less than a miracle. It would, indeed, change the whole outlook of the world. Originally the three great types of mankind—white, yellow and black—were restricted practically to certain regions of the earth. The white man, the seaman *par excellence*, has spread himself over the whole habitable globe; he makes his home everywhere; and in search of food and materials for his manufactures he enters remote regions, that he would never have heard of but for ships and the stout hearts that man them.

A ship "walks the waters like a thing of life"; she is one of the highest efforts of human invention; she battles with and triumphs over wind and wave; she interchanges blessings between the uttermost ends of the earth; and she ever helps to bind closer the peoples of the world. Solomon said that one of the most wonderful things was "the way of a ship in the midst of the sea," and with all our present-day knowledge we are forced heartily to agree with him.

CHAPTER XIV

EARLY STEAM NAVIGATION

THE steam-engine was not many years old before it was put to other purposes than pumping water; it invaded the spinning and weaving world to work the marvellous machines invented by Hargreaves, Arkwright, and others; in the year 1814 the *Times* newspaper was printed by a steam press for the first time; and there were few mechanical appliances to which steam was not being experimentally applied.

Steam traction was engaging attention long before the appearance of Hedley's "Puffing Billy"; but steam navigation had occupied men's thoughts centuries earlier. The use of wheels in the propulsion of boats was certainly known before the Christian era, for a Roman army was conveyed to Sicily in boats, the motive power of which was paddle-wheels worked by oxen.

Blasco de Garay, in 1543, is said to have moved a ship of 200 tons by means of paddle-wheels, kept in motion by "a vessel of boiling water."

Almost two hundred years earlier Roger Bacon, who is credited with the invention of gunpowder, certainly had some ideas upon the subject, for he stated that "the largest ships, with only one man guiding them, will be carried with greater velocity than if they were full of sailors." Coming to the year 1690 we find Dr. Papin, who first used the piston and cylinder, almost comically experimenting with a model boat propelled by paddle-wheels. His engine was only a steam pump that forced up water to turn a wheel, which in turn revolved the paddles.

In the course of the next hundred years came the invention of the steam-engine by James Watt, and steam navigation forthwith became almost an assured possibility, if continued effort and unceasing experiment in Britain, France, and the United States counted for anything. The Americans, in particular, were forging ahead, and John Fitch constructed several boats worked by paddles, or fins, placed either at the sides or the stern. The engines were of the awkward beam pattern, working very small cylinders and developing a speed of only four miles an hour. In another attempt Fitch actually used a screw apparatus, the principle, which in later years, practically solved the question of rapid ship propulsion.

Mr. Patrick Miller, a banker of Dalswinton, was led to take an interest in steam navigation in his desire to ameliorate the sufferings of those at sea. With the assistance of Mr. James Taylor, his son's tutor, were commenced various experiments, which led to William Symington, an Edinburgh engineer, joining them. Eventually a double-hulled launch was constructed, in which the boiler was on one deck and the engine on the other. The paddle-wheels were between the hulls, and power was transmitted to the shafts by means of chains. Shortly, Miller and Taylor refused to incur further expense, leaving Symington to work alone until Lord Dundas became interested in the subject. The result was the building of the "Charlotte Dundas" in 1801. She was only 56 feet long and had a double stern, the paddle-wheel working in a covered-in recess between the two rudders. She was employed in towing barges on the Forth and Clyde canal, and was so great a success that steam navigation became quite a rage. Symington's vessel, however, was forced to cease operations, because the wash from the wheels played havoc with the canal banks; and the "Charlotte Dundas" was laid up at one of the locks for several years.

Of several inventors in the United States, Nathan Read deserves mention for his invention of a cylindrical tubular boiler, practically as in the common locomotive of to-day. Samuel Morey constructed both side-wheeled and stern-wheeled boats, capable of five miles an hour, but he had to cease his experiments because his funds were exhausted.

Among American steam navigators Robert Fulton worked himself up into the forefront. He experimented with paddle-wheels while he was a mere boy. In later years he was apprenticed to watchmaking, but he abandoned it to take up the profession of an artist. In the pursuit of his studies he visited both England and France, in which countries he watched with interest the various attempts to construct a practicable steamship.

At the age of twenty-eight Fulton deserted art, and in Paris commenced to busy himself with torpedoes and torpedo boats; and the British were not a little concerned lest he should succeed and place his inventions at the disposal of the French, with whom we were then at war. He was joined by Livingston, a fellow countryman, and the couple seriously took up the question of the steamboat. In their first venture in the spring of 1803 the heavy machinery broke the vessel's back, and it sank into the mud of the Seine; but in the autumn the reconstructed boat steamed up the river at four-and-half miles an hour, to the wonder of a vast concourse of spectators.

Failing to enlist the interest of the French Government either in torpedoes or boats, Fulton went to England early in 1804, where he not only inspected the "Charlotte Dundas," but also obtained drawings of her machinery. He then supplied Messrs. Boulton and Watt with designs for a new engine, though he took care not to disclose the purpose to which he proposed to apply it. The engine was despatched to the United States and Fulton and Livingston built the "Clermont." Her length was 133 feet, beam 18 feet, and depth 9 feet. She was launched on the East River, New York, in 1807. She was not only the biggest steamship afloat, but was the most successful, for the "Clermont" steamed to Albany, a distance of 150 miles, in 32 hours.

This new steam-driven vessel created a tremendous sensation, especially at night, among those who "go down to the sea in ships, that do business in great waters." Using pine wood for fuel, the flames and sparks from the funnel gave the new monster a rather terrifying aspect. The crews of sailing vessels noted with wide-eyed surprise that the "Clermont" forged along regardless of wind or tide; but with its nearer approach, the clatter of the machinery and the thrashing of the paddle-wheels caused many a simple sailor man to hide below deck, and some even hastily made ashore, beseeching Providence to protect them from "the monster, which was marching on the tides and lighting its path by the fires

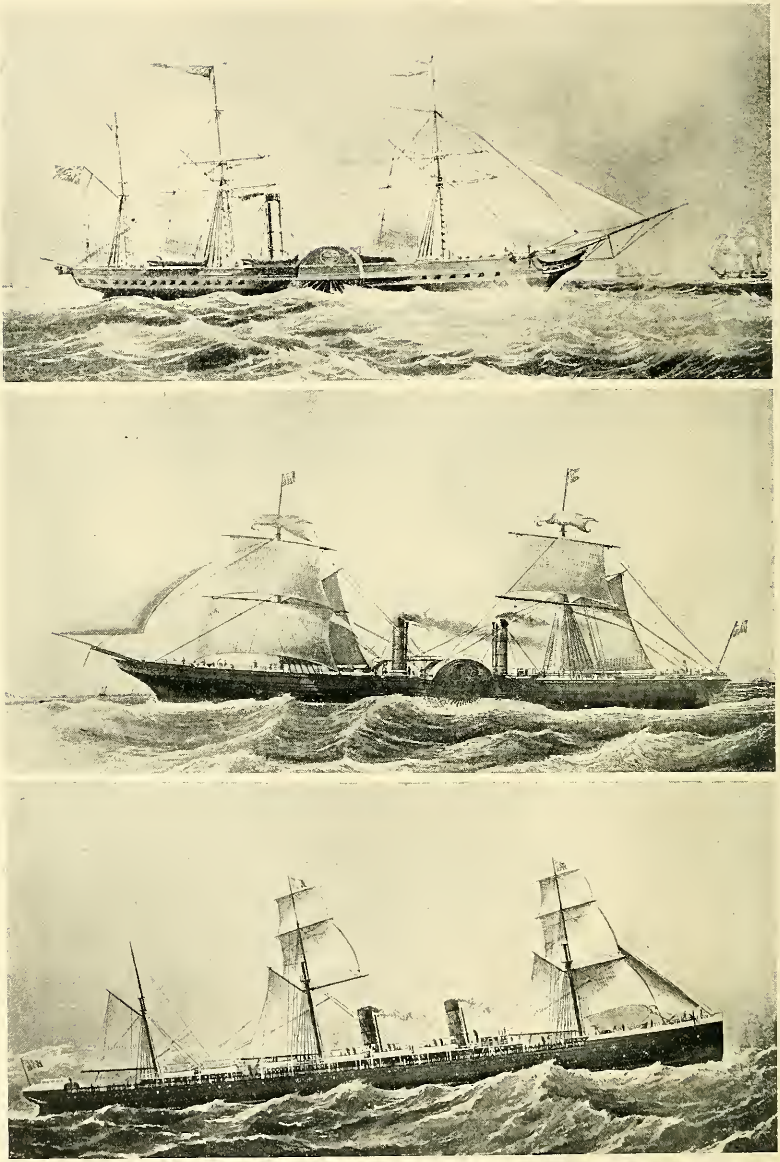


PLATE XXXI.

EARLY CUNARD STEAMSHIPS.

1. "BRITANNIA" (1840). 2. "PERSIA" (1856). 3. "SERVIA" (1881).

which it vomited." Fulton and Livingston had many rivals, some of whom had really attained equal, if less public, success, but Fulton and his partner could claim to be the first to demonstrate that steam navigation might be turned to profitable account.

Meanwhile British steam navigators had not been idle. The Duke of Bridgwater had placed eight steamboats, sisters to "Charlotte Dundas," on his canal between Manchester and Runcorn, where they were employed in towing barges; and but for the fact that the Duke died shortly afterwards, William Symington might have figured more largely in the evolution of the steamboat.

The year 1812 was a notable one in the history of British steam navigation. Henry Bell, of Helensburgh, constructed the "Comet," a launch of 30 tons burden, with four paddle-wheels, two on each side, driven by an engine of about three horse-power. This was the first practical steamboat built for the purpose of plying for hire between Glasgow and Helensburgh, although it took several years to gain public confidence in the new invention.

Two years later, George Dodd produced the "Majestic," which steamed from Port Glasgow to Dublin, and from thence rounded Land's End and in due course reached London. Dodd was not only an enthusiastic engineer but he infected others with his belief in the possibilities of steam navigation. In a very short time he had half a dozen steam vessels plying on the Thames, four between Gravesend and Richmond, and two between London and Margate. The passage between Gravesend and London occupied about six hours. These early steam vessels were worked by beam engines, which was the popular type for stationary work ashore. The splashings and hot-water escapes gave rise to no little ridicule on the part of opponents and unbelievers in the new method of propulsion; and, in fact, about that time engines of any kind were the subject of much adverse comment, thanks to the frequency of boiler explosions.

The Americans were preparing a surprise for the shipping world. A full-rigged ship of 350 tons sailed regularly between New York and Savannah. This vessel was fitted with steam machinery and paddle-wheels. She made a trial voyage on her usual route, and then on April 27, 1819, left Savannah for St. Petersburg. The "Savannah," as the vessel had been re-named, crossed the ocean until, when off Cork, she encountered greater danger than the rollers of the Atlantic. A British admiral sighted the "Savannah" and despatched his cutter to make inquiry concerning "the bark which had no sails." The American vessel, however, steamed on until fire was opened upon her and she was brought-to for inspection by the naval officials. The steamship resumed her voyage, and all along the coasts to Liverpool her coming was signalled as though she were a ship afire.

The "Savannah" reached Liverpool after a voyage of twenty-nine days, but for a quarter of that time she was under sail instead of steam. This was owing to no fault in the machinery, but simply because the vessel could not carry sufficient pine wood fuel for steaming so great a distance at only five knots an hour. From Liverpool the vessel proceeded to St. Petersburg and eventually returned to America, where her machinery was removed and she reverted to a sailer on her old route. Six years later another American vessel voyaged to India in forty-seven days; and in this case also, upon the return home, the machinery was dismantled because steam navigation was not yet a pecuniary success.

A few facts will serve to show how steam navigation was coming into favour. In 1818 Napier's steam-packets commenced to run between Greenock and Belfast; and three years later steam-boats were at work between Liverpool and Birkenhead, Holyhead and Dublin, London and Leith, and Calais and Dover. In 1825 the "Enterprise," a vessel 120 feet long and of 470 tons burden, essayed a steam voyage to the East. She reached

Calcutta, *viâ* the Cape, in 113 days; and though her engines were at work for only about half the passage, Captain Johnson secured the prize of £10,000 that had been offered for the first steamship making the voyage to India. In a passage to the East, a steamship enjoyed facilities for coaling at various points along the route, but to cross the Atlantic entailed steaming from land to land with one load of coal.

In 1838 two British steamships essayed the feat of crossing the Atlantic. The "Great Western" was a vessel of 1340 tons and 450 horse-power; her wheels were 28 feet in diameter, with paddle floats 10 feet long; and she carried 600 tons of coal for fuel. The "Sirius" was little more than half the tonnage, with a driving capacity of 250 horse-power.

The "Great Western" sailed from Bristol on April 8, four days after the "Sirius" had commenced the voyage from Cork. The Atlantic weather was not at all propitious, for the wind was dead ahead nearly the whole way across, and heavy seas were encountered. Nevertheless both vessels arrived at New York on the same day, April 23, where they met with an enthusiastic reception. The forts and the war vessels in the harbour saluted with their guns; mercantile craft dipped their pennants; great multitudes assembled to cheer the navigators; and the newspapers gave detailed accounts of the machinery that had achieved so notable a shipping record.

On the return passage the "Sirius" reached Falmouth in eighteen days; the "Great Western" made Bristol in just over a fortnight, although during some very heavy weather she could steam only at the rate of two knots an hour. The "Sirius" returned to work on her old route between London and Cork, but the "Great Western" remained on the route for which she had been built; and in the next half dozen years made no less than seventy passages between the Old and New Worlds. Her quickest voyage westward was 12 days 18 hours, and the fastest eastward eleven hours less.

It will be well to note in what respects the "Great Western" was an improvement upon the "Savannah." The paddle-wheels of the earlier steamers were skeleton wheels of iron, on the outer radii of which were fixed flat boards called floats or paddles, which, as the wheel revolved, beat upon the water with much the same effect as if they were the blades of huge oars. A great improvement was introduced in 1829 in the "feathering" paddle-wheel, in which the floats were mounted on axes, so that while they were immersed they were at right angles to the water, thus giving additional force to the revolutions of the wheel. The substitution of coal for wood fuel meant more easily sustained heat for generating the extra steam that was required for the bigger cylinders now in use.

Within the next five years the "Great Western" was joined by half a dozen British steamships, one of which, the "Great Britain," launched in 1843, was the finest ship on our side of the Atlantic, and although the Americans had made enormous strides it was doubtful if they had evolved a better vessel. The "Great Britain" was 289 feet long, or quite 50 feet longer than the "Great Western"; and her engines could exert 1000 horse-power. In two respects this vessel showed great departures from any ocean-going vessel that had preceded her; she was made of iron, and instead of paddles was fitted with a screw propeller.

It is worth noting that an iron ship, the "Vulcan," was built as early as 1818, and this vessel was still at work carrying coal in 1875. Iron, however, found little favour in the eyes of the shipbuilder until the year 1834, when the "Garry Owen," another iron vessel, 125 feet in length, went ashore in the Shannon between Limerick and Kilrush. The fact that the "Garry Owen" suffered but little from the experience, while many wooden ships in the same storm became total wrecks, did much to bring iron into favour.

In any case, all-round improvements were in the air, and the giant Steam was surely entering into his kingdom. On land the iron-horse was making enormous progress, important railways were already in actual working, and scores of others were in course of construction. It was now possible to travel by rail from Liverpool or Manchester to London, and from thence to Southampton or Bristol. There were now in British ports probably quite a hundred steamships, the best of which could not exceed eight knots an hour. The railway engineer had overcome his chief difficulties, and his marine brother might be trusted to come through his own ordeal with similar success. Of course, speed of movement in water could never equal that achieved on land, but with the arrival of the screw propeller, the greatest speed attained by paddle-wheels would be put completely in the shade.

The substitution of iron for wood in the construction of ships and the adoption of the screw propeller gave an immense impulse to steam navigation. Sentiment was at the bottom of much of the objection to the use of iron; but in many quarters it was considered a ridiculous assumption that large iron bodies could be made sufficiently buoyant for shipping purposes. Upon the face of it one might, indeed, easily conclude that a wooden ship would float better than an iron one, until we realise that any floating body displaces its own weight of water.

We will examine this statement, and by means of a very simple experiment ascertain exactly what it means. Take any small model vessel and float it, carefully marking how much of the vessel is submerged. Now remove the ship from the water and press it into modelling clay to the same depth; and when we lift up the model we find a clay cast which is an exact representation of that portion of the hull which was beneath the water when the vessel was afloat. If we fill the mould with water, it proves to a nicety the quantity of water which the vessel displaces. No matter how large a vessel may be, its displacement is a matter of simple calculation, after the cubical displacement of the water has been ascertained; water weighs about $62\frac{1}{2}$ lbs. per cubic foot, and thus the displacement is easily reducible to tons.

Now we will note what effect the substitution of iron had on a vessel's displacement. Though bulk for bulk iron is heavier than wood, a less quantity of the former is required to obtain the necessary strength. A wooden ship had to be of an enormous thickness to withstand the strain to which an ocean-going craft is subjected, whereas quite a comparatively thin sheet of iron is sufficiently strong, lighter in weight, and consequently of less displacement and more buoyant.

The screw propeller had been suggested at the end of the seventeenth century, quite a hundred years before James Watt gave consideration to the subject. John Fitch constructed a small screw yawl, but his compatriot, John Stevens, was perhaps the first to apply the screw principle with anything like success; and it ought also to be put on record that Trevithick, whose interest in steamships was second only to that of steam traction on land, believed in the feasibility of the screw, and as early as 1812 was proposing an iron-hulled vessel.

John Ericsson, a Swedish engineer resident in England, can claim most of the credit for the introduction of the screw into British shipbuilding practice. His trial vessel was only forty feet in length, drawing but three feet of water and registering only six tons. A double screw was used, a right hand and a left, and able to revolve in opposite directions, because the two shafts were placed one within the other. The little steamer well demonstrated its capability as a tug, for it towed a load of 140 tons at seven miles an hour; and on the Thames it towed a heavy American packet ship at five miles, while alone it attained a speed of ten miles an hour.

The outcome of Ericsson's success was the formation of the "Ship Propeller Company," whose first vessel, the "Archimedes," showed a speed of nearly ten miles an hour, which was a great improvement for a vessel 106 feet long and

230 tons burden. This vessel voyaged from port to port and even steamed round Great Britain, but when the "Archimedes" was finally sold, the Company found that the experiment had resulted in a loss instead of a profit.

Ericsson visited the United States, where he built a still larger screw vessel, and at the same time other ships were being built in England and France from his designs. These vessels did for steamships what Stephenson's "Rocket" did for locomotives — the screw propeller indubitably proved its superiority over the paddle-wheel, and when in 1843 the "Great Britain" made her appearance, she was only one of nearly thirty screw vessels that took the water in the same year.

There is no need to describe how an ordinary screw bores through wood, which in the beginning suggested the marine screw for boring through the water. Brunel's screws on the "Great Britain" had six blades, but the modern use is pretty generally restricted to three or four; two blades are capable of perhaps greater speed, but with the disadvantage of considerably more vibration. Ever since the days of Ericsson marine engineers have been improving the screw, and there is little doubt that perfection has by no means yet been achieved. For large ships twin, triple, and even quadruple screws are used. Triple screws are shown on Plate XLIII. The great curved blades hurl the water astern with a circular motion, the speed, of course, depending upon the rapidity of the revolutions; the screws of the "Archimedes" revolved 140 times a minute, compared to the 300 of a modern fast-steaming ocean greyhound.

At first ship builders were hampered in adopting the new aid to speed, simply because the substitution of a rapidly revolving screw for a slow-moving paddle-wheel called for steam-engines different in design from any then in use; and new engines can only be produced after long experiments, in which accidents and blunders occur to create delays, although they may be the means of driving home valuable lessons.

We have read how locomotive builders are ever striving to improve the boiler, seeking to add to the heating surface, so as to provide quicker conversion of water into steam; and in consequence the railway boiler has reached the limit of size that the bridges and tunnels will allow. The marine engineer suffers from less restrictions in this respect, and although he has to construct engines of enormous power, he has a reasonable space in which to erect them. Marine boilers are not only bigger than the locomotive boiler, but there is considerable diversity in design. On board ship a boiler may be twenty feet in length, and diameters range up to eighteen feet. Many of the longer boilers are fired at each end, and are known as double-ended, and at either end there may be more than one furnace.

The early boilers were little better than huge kettles fired from the outside, until the adoption of tubes about the year 1850. Among numerous marine boilers the water-tube type must be mentioned. In a locomotive boiler the furnace gases, escaping by way of the tubes, impart heat to the water in which they lie; but in the water-tube boiler the water is in the tubes themselves, the flames playing directly around them. In a water-tube boiler steam is raised very quickly, in at least a third of the time occupied by one of the ordinary type, and a 300 lb. pressure can be carried with safety; but in general practice the water-tube boiler is less reliable and always calls for extra care in working. At any rate, British shipping lines have hitherto refused to follow the lead of the French Messageries Maritimes, which adopted the water-tube type of boiler some years ago.

The engines that were chiefly used for propelling the early paddle steamers were of the side-lever type; and those produced by Messrs. Boulton and Watt from the year 1820 and onwards were in great favour. In this type the cylinder or cylinders were fixed vertically on the floor of the ship, a side lever being pivoted to a shaft placed low down in the vessel. Engines of this type call for the minimum of attention in working and are still in common use on tug boats. In the United States side-wheel steamers were usually worked by beam engines, and as in both systems the motion of the piston rod is transmitted to the connecting rod by some kind of beam, they may be largely viewed as almost similar in practice.

British locomotive engineers have practically banished the compound engine from our railways, but its suitability for marine propulsion was proved in the middle of the last century. John Elder, a member of a Glasgow shipping firm, was a staunch advocate of the double cylinder; and in the years 1850–1867 Elder and his partners used compound engines in various new vessels, which resulted in a saving of as much as 50 per cent. in coal. The marine compound engine marked an important era in shipbuilding; in a few years it was followed by the triple expansion engine; and nowadays shipbuilders have adopted quadruple expansion with correspondingly better results.

CHAPTER XV

THE BLUE RIBBON OF THE ATLANTIC

IN 1835, at a meeting of the Royal Institution in Liverpool, Dionysius Lardner thus delivered himself: "As to the project which is announced in newspapers of making the voyage directly from New York to Liverpool, it is, I have no hesitation in saying, quite chimerical, and they may as well talk of making a voyage from New York or Liverpool to the moon!"

What must have been the worthy professor's thoughts when even the little "Sirius" made sport of him? Only three years later the British Government was inviting tenders for an Atlantic steam mail service. The man most likely to entertain such a project was George Burns of Glasgow, who had worked wonders for our coasting trade; but he decided that his operations were already sufficient to occupy all his energies.

The Government circular fell into the hands of Samuel Cunard of Halifax, Nova Scotia, a wealthy Quaker, whose forbears had emigrated from Wales in the seventeenth century. He firmly believed that it was possible to establish between the Old and New World a steamship service which should run with the regularity of a railway train. The Nova Scotian came to England and got into touch with George Burns, Robert Napier, a rising engineer, and David MacIver of Liverpool. The quartette decided to form a company with a capital of £270,000, and in due course obtained a seven years' mail contract for a fortnightly service between Liverpool, Halifax and Boston. This was the foundation of the Cunard Line, a name that will ever be famous in the annals of British shipping.

In 1840 the new company put out four Clyde-built boats—the "Britannia" (Plate XXXI), "Acadia," "Caledonia" and "Columbia"—wooden paddle-wheel vessels, but the first mail steamers to make their appearance on any ocean. The "Britannia," 1154 tons, made her first voyage from Liverpool to Boston in 14⅓ days, her speed averaging 8½ knots an hour. The people of Boston were most enthusiastic Cunarders, and when in the winter of 1844 the "Britannia" was frozen in their harbour, the people cut a canal of seven miles through the ice to the open sea, so that the vessel was only delayed 48 hours. The Cunard Line, however, could not afford a repetition of any such Arctic experience, and thus the calls at Halifax and Boston were dropped, and the vessels made New York their American headquarters.

The Cunard record forced American navigators into greater activity, and there came a time when the "Washington" left Liverpool on the same day as the "Britannia," with the declared intention of lowering the British supremacy. The "Washington" reached New York in due course, by which time the "Britannia" had been unloading a couple of days. This was the first international race across the Atlantic. The result was not soothing to American pride, and steps were soon in progress to bring about an alteration. Mr. E. K. Collins's clippers had been among the most notable vessels of their day, and the go-ahead Yankee, aided by a Government subsidy, inaugurated the Collins's Line, avowedly to "sweep the Cunarders off the ocean." His first quartette of new vessels consisted of the "Atlantic," "Arctic," "Baltic" and "Pacific." The first-named was 276 feet in length, 45 feet beam, and 31½ feet in depth. The breadth over the paddle-boxes was 75 feet; the main saloon was 70 feet long and the dining saloon was 60 feet by 20 feet. No vessel had ever been floated in which there was such luxurious accommodation for the passengers. Mr. Collins was speedily the proudest man in the shipping world, for in 1851 the "Baltic" steamed from Queenstown to New York in 9 days 11

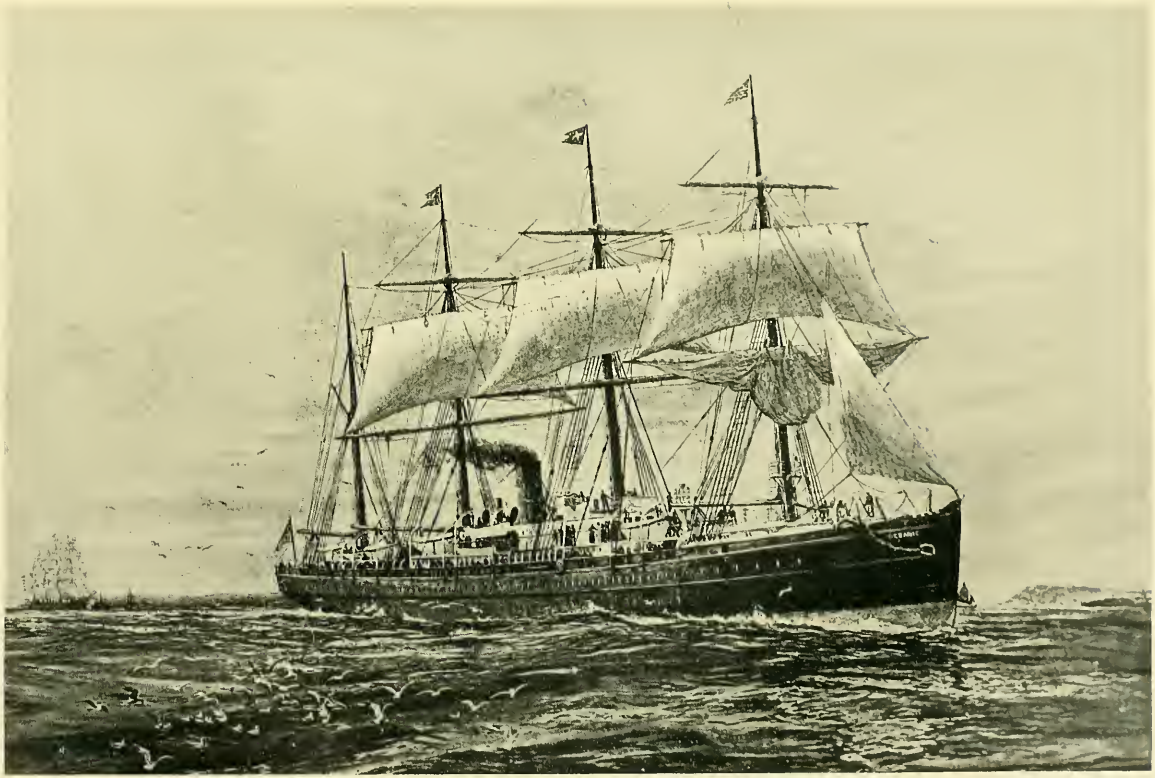


PLATE XXXII.

WHITE STAR S.S. "OCEANIC" (1871).

hours; and the "Atlantic," a year later, with 9 days 17 hours, set up a new record for the eastward passage. The career of the Collins's Line, however, was meteoric in the extreme. To reckless expenditure was added the loss of two of the vessels, in which disasters hundreds of passengers lost their lives, and in 1858 this American line ceased to exist.

This same year witnessed the launch on the Thames of the "Great Eastern," an iron vessel propelled by paddles and a single screw: Length nearly 700 feet; width 83 feet, or 120 feet over the paddle-boxes; gross tonnage, 10,000. She was designed to carry passengers and crew, totalling 4400, in the British and Australian trade, but was placed on the Atlantic route, where she proved to be a commercial failure. From a purely sea-going point of view the vessel was a success, attaining a speed of 15 knots on the preliminary trial trip. In the years 1865–66 the "Great Eastern" laid two ocean telegraph cables, and in 1888 was sold to be broken up.

The disappearance of the Collins's Line had not restored to the Cunard Line its lost prestige, and consequently the British company set out to go one better than their unfortunate competitors. Of various new vessels the champion was found in the "Servia" (Plate XXXI), which set up a record of 8 days 3 hours for the homeward run in 1863, and three years later 8 days 4 hours 31 min. for the outward voyage.

Mr. William Inman had founded the Inman Line in 1850, with vessels trading between Liverpool and Philadelphia until 1856, when New York was made their terminus. This Line made a striking departure in Atlantic navigation. Their first vessel, the "City of Glasgow," was 227 feet long and 1610 tons register; she was built of iron and was the first Atlantic screw passenger steamer, although the accommodation was for steerage passengers only. The Cunarders did not build an iron steamship until six years later, when they floated the "Persia" (Plate XXXI). This was, perhaps, the most beautiful steamship that had yet been seen; she was 376 feet long and registered 2079 tons; she was two-masted, brig-rigged, but was propelled by paddle-wheels.

There had been two great objections to the employment of iron for the hulls of vessels; so great a mass of metal had a disturbing effect on the compass, and the ship's bottom was soon fouled with vegetable and animal growths that had the effect of retarding speed. The invention of the floating compass at least partly remedied the first difficulty, and the second was ameliorated by painting the submerged portion of the hull with a composition that forbade the rapid attachment of weeds, barnacles, etc.

Really the increasing adoption of iron in the construction of vessels spelt the salvation of the British shipbuilding industry, for our native supply of timber could not have coped with the demand. In the reign of James I. fifty cubic feet of oak cost less than 30*s.*, whereas it now costs quite five times as much; and if wood had retained its supremacy, the shipbuilding yards of Britain would have lost their business to those countries which had a huge supply of timber, such as the United States. But Britain was at the head of the world's iron industry; and thus not only made her own vessels, but very largely those of other countries.

In 1867 the racing honours fell to the Inman steamship "City of Paris," a vessel of 2651 tons, which did the run from Queenstown to New York in 8 days 4 hours; and in 1869 the "City of Brussels," 3081 tons, secured the distinction of accomplishing the homeward voyage in a little under 8 days.

The Inman Line quickly found another candidate in the field, or rather on the water, anxious to set up fresh records. What afterwards became the White Star Line was only established in 1869 by Messrs. Ismay, Imrie & Co., for whom Messrs. Harland & Wolff of Belfast constructed splendidly appointed vessels, of which the "Oceanic" (Plate XXXII) was a notable one. The young firm speedily got to business, and in 1872 their "Adriatic" compassed the outward passage in 43 minutes under the 8 days; and during the next year the "Baltic" reduced the homeward passage to 7 days 20 hours 9 min. These records only lasted until 1875, when the Inman Line snatched the honours from its younger rivals by means of the "City of Berlin," 5491 tons, which laid to its credit an outward passage of 7 days 18 hours 2 min. In later years this was the first vessel to be lighted by electricity.

Only a year later the "White Star" regained the lost laurels. The "Britannic," 5004 tons, cut the outward record several times until it stood at 7 days 10 hours 53 min.; her sister vessel, the "Germanic," in the same year reduced the homeward passage to 7 days 15 hours 7 min., only for the "Britannic" to outvie it by two hours and a half.

Meanwhile the Guion Line, founded in 1866, had been making frantic efforts to secure a share of the trans-Atlantic honours without success. Eventually it was decided to construct the "Arizona," 5147 tons, and the vessel made its mark on both passages; the outward voyage, 7 days 10 hours 47 min., and the homeward, 7 days 8 hours 11 min. In 1882 the "Alaska" made an onslaught upon the outward passage and cut the record down a further 6 hours; the

PLATE XXXIII.

CUNARD S.S. "CAMPANIA."

homeward passage she achieved in 6 days 22 hours, the first vessel to cross the Atlantic Ocean within a week. It was to the "Arizona" or the "Alaska" that the title "ocean greyhound" was first expressly applied.

These last-named notable performances were wiped out in 1884. The National Line's "America" in June made the eastward passage in 6 days 14 hours 8 min. A couple of months later the "Oregon" steamed into fame on both trips, making the passage from Queenstown to New York in 6 days 9 hours 42 min., and the return voyage in 6 days 11 hours 9 min. This vessel had been built for the Guion Line, but the Cunard Company had purchased her before she obtained her double first.

With the reduction of the Atlantic passage to six and a half days, it appeared that the shipbuilder was assuredly approaching finality in the matter of speed. Possibly the Cunard Line viewed the possession of the championship as savouring somewhat of chance, in that the "Oregon" was constructed to the orders of a rival company; and instructions were issued for building two new steel screw vessels capable of spoiling all existing records, and thus from Fairfield came the "Etruria" and the "Umbria," each 8127 tons. In 1885 the former made short work of the "Oregon's" outward record, which she cut down to 6 days 5 hours 31 min., and the "Umbria" beat this by 50 min. a couple of years later. The next year, however, the "Etruria," steaming at nearly 19 knots an hour, defeated her sister's outward performance by very nearly 3 hours (6 days 1 hour 55 min.), and set up a new homeward record with 6 days 4 hours 36 min.

But the old Inman Line, now the Inman and International, had built a new "City of Paris" and the "City of New York," and again came into the pace-making business with almost paralyzing effect. Their old "City of Paris" in 1867 did the outward passage in 8 days 4 hours, but in 1889 her namesake reduced it to 5 days 19 hours 18 min.; and the passage from New York to Queenstown occupied only 5 days 22 hours 53 min. She was the first boat to accomplish each passage under the 6 days. The first "City of Paris" was a vessel of 2651 tons; the new one was 527 feet long, 63 feet beam, 39 feet deep, with a displacement of 10,499 tons.

The Inman Line held the record only until 1891, when the White Star "Teutonic," the first of that company's twin-screws, reduced the outward record by 2 hours 47 min., and the homeward by 1 hour 50 min. This rival achievement served only as a tonic for the Inman boats, for in the next year the "City of Paris" beat the "Teutonic's" outward passage by over 2 hours; and the "City of New York" lowered the homeward passage by 66 min. The records now stood: outward, 5 days 14 hours 24 min.; homeward, 5 days 19 hours 57 min.

The year 1893 opened the new era of the leviathans, for the Cunard Line floated the "Campania" and "Lucania," each about 600 feet long and 12,950 tons. The "Campania" (Plate XXXIII), the first Cunard twin screw, on her first outward run failed to make the quickest passage on record, but, nevertheless, it was the fastest voyage that any steamer had ever made on a maiden trip; but for the homeward voyage she set up the record time of 5 days 17 hours 27 min.

Four years later the British shipping records were menaced by an entirely new competitor—Germany was entering the lists. The Norddeutscher Lloyd Company produced the "Kaiser Wilhelm der Grosse," a vessel 648 feet long, 66 feet beam, and 43 feet in depth, with a displacement of 14,350 tons; and she had twin-screws driven by triple-expansion engines with indicated 28,000 horse-power.

The German leviathan's performances deserve careful consideration, if only for the effect that they had on British shipbuilders. On September 26, 1897, the "Kaiser Wilhelm der Grosse" left the Needles, and, steaming at an average speed of just over 21½ knots an hour, reached Sandy Hook (New York) in the wonderful time of 5 days 22 hours 35 min.; on the return voyage she made Plymouth in 5 days 15 hours 10 min., an average of 21·9 knots an hour. Be it noted that these were but trial trips, and better results might be looked for. The German vessel did not disappoint expectations, for in the next year she did the westward run in 5 days 20 hours 5 min., and the eastward in 5 days 17 hours 8 min., which last meant an average of 22⅓ knots an hour. In the same year she set up a record for one day's steaming with 580 miles, a marvellous performance, even if the sea were smooth and she had the advantage of a gentle breeze.

This German invasion of the Atlantic records provided scope for amazed reflection on the part of British navigators, but worse was to follow. The Hamburg-American Line viewed with envy the success of the Norddeutscher Lloyd vessel, and on January 10, 1900, in the presence of the Emperor, was launched a vessel that was calculated to outpace the "Kaiser Wilhelm der Grosse."

The dimensions of the "Deutschland" (Plate XXXIV) were 663 feet in length, 67 feet beam, 44 feet depth; 16,502 tons; and if there were virtue in size she might be expected to shake the records very considerably. In July she left Plymouth on her maiden voyage to New York and, steaming at 22·4 knots an hour, practically laughed at every record hitherto set up by Atlantic navigators; the outward record was reduced to 5 days 15 hours 46 min.; and on the homeward voyage the "Deutschland" averaged 23 knots an hour and similarly smashed all eastward records.

Though Britain might still boast that she was the mistress of the sea, she was no longer the keeper of the Atlantic records; and on September 14, when there began a great race for the championship, no British ship was even a competitor. The "Kaiser Wilhelm der Grosse" left New York, and an hour and a half later the "Deutschland" followed in her track. She was in the rear only until noon on the second day, from which point she took the lead, reaching Plymouth in 5 days 7 hours 38 min., thus beating her own record by nearly four hours, a result that worked out at 23·36 knots an hour. At the finish of the race the "Kaiser Wilhelm der Grosse" was about ten hours astern of her rival, but on June 20, 1904, she turned the tables on the "Deutschland" by attaining a speed of 23·59 knots, over a rather longer course, which occupied 5 days 11 hours 58 min.

It will have been noticed that the quickest homeward passage always occupies a longer time than the westward passage. The Atlantic is the busiest ocean in the world, and it is traversed by more ships than on the other oceans put together.

Between the United States and Canada and the British Isles the traffic is enormous, and care has to be exercised to eliminate as far as possible the risks of collision. All vessels going westward take a well-defined course that on the charts is known as an "ocean lane"; the eastward and rather longer lane lies further to the south. Collisions on the Atlantic Ferry are therefore rare, one vessel might run down another going in the same direction, but not meet it stem to stem. In certain seasons of the year, especially in the Canadian service, there is far greater risk of colliding with icebergs, which are brought southwards by the Labrador current. In November, 1879, one of the first ocean greyhounds, the "Arizona," when steaming at full speed intent upon a record, crashed into an immense iceberg. The vessel's bows were crumpled up, but her bulkhead remained intact, and she was able to make St. John's, the nearest port.

At the beginning of the 20th century Britain lost more than the blue ribbon of the Atlantic, when American capitalists promoted a huge shipping combine, the International Mercantile Marine Company, consisting of three American and two British lines, with a capital of £34,000,000, and whose steamships totalled 878,000 tons. It certainly was disturbing to think that the famous White Star Line could no longer be accounted exclusively British. The Cunard and other British lines, however, remained loyal to the motherland, and thus the Anglo-American combine found that it had possibly paid too high a price for its huge tonnage, in the face of the stern competition of the purely British lines for passengers and freights.

When the Cunard Line lost the championship of the Atlantic to the "City of Paris" in 1867, it did not regain it until 1885, if we exclude the performances of the "Oregon," which was purchased from another company. The Cunarders again rested upon their laurels after the defeat of the "Campania" by the "Kaiser Wilhelm der Grosse."

The "Deutschland" had cut all ocean records, but the victory was gained at a cost that the Cunarders refused to pay. The German vessel in building cost twice as much as an average Cunarder, burnt nearly four times as much coal per day, and required more than double the crew of the British vessel. The German boat had accommodation for 1050 passengers, of whom 450 were 1st class; the British carried only 160 1st class paesengers, but somewhat atoned by providing for 1600 in the steerage. In cargo capacity there was no comparison between the two vessels; the German carried 600 tons of freight, where the British load was 11,600 tons. The result was, that the record for speed was obtained only by an enormous increase in the cost of fuel, and the sacrifice of cargo carrying capacity that made any profit on a voyage almost an impossibility.

For a moment we must leave the Atlantic Ferry in order to watch the invention and progress of a new aid to speed in steam navigation. In 1884, Mr. C. A. Parsons invented a steam turbine, which, strangely enough, was only a scientific development of the apparatus with which Hero of Alexandria experimented more than 2000 years ago.

In the turbine there is a cylindrical-box containing a spindle mounted with a number of metal discs, which have vanes set slantingly at their circumference. When steam is admitted to the cylinder, it acts upon the vanes very much in the same manner as the sail vanes of a mill are acted upon by the wind, or the buckets of a wheel forced round by water. From the point where the steam is admitted, the vanes and wheels increase in size, and so the expanding steam finds a greater surface upon which to exert its force; and steam which enters the cylinder at a pressure of 200 lbs. per square inch, leaves it at a velocity of about three-quarters of a mile a second, or quite two-thirds of the speed of a bullet shot from a modern rifle. Mr. Parson's turbine of 1884 attained a speed of 18,000 revolutions a minute.

A turbine engine is not more than half the weight of the ordinary reciprocating engine; and

PLATE XXXIV.

HAMBURG-AMERICAN S.S. "DEUTSCHLAND."

NORDDEUTSCHER LLOYD S.S. "KAISER WILHELM II."

the boilers remain the same, as it is not a question of increased steam consumption, but only obtaining all possible velocity out of the steam that is generated. Hitherto, in all steam-driven vessels travelling at high speed, there was much vibration, which caused passengers almost as much discomfort as the rolling and pitching due to the motion of the waves. Vibration, too, has a wearing effect on the machinery generally; and, in a rough sea, when the propeller is lifted out of the water, the screw "races" at perhaps double its normal rate, creating a very disagreeable motion for passengers and carrying severe strain to the engines. In a turbine-driven vessel there is an almost complete absence of vibration, and, as the propellers are obliquely set deeper in the water, there is no racing and practically no loss of speed, even in a rough sea.

The first turbine vessel, the "Turbinia," made her appearance at the Diamond Jubilee Naval Review, in 1897, and the little craft of 44 tons, with engines developing 2000 horse-power, darting about amongst the monster warships of the many nations at the rate of an ordinary express train, showed that we were commencing a new era in steam navigation.

The Allan Line, since 1852, has had excellent steamships trading between Liverpool and Quebec, and they were the first to despatch turbine steamers across the Atlantic—the "Victorian," 10,000 tons, and the "Virginian," 12,000 tons (Plates XLIII and XLIV). On June 9, 1905, the "Virginian" left Moville at 2 p.m., and at 11 p.m. on June 13, she passed Cape Race, Newfoundland, beating the Canadian record by about twenty hours.

In the meantime the Germans had built the "Kaiser Wilhelm II.," 20,000 tons (Plate XXXIV), and the "Kronprinz Wilhelm," 14,908 tons, and the various crack German vessels had raced each other until the rapidly succeeding records were a complete maze of brilliant performances, of which, in view of their approaching annihilation, specific details may be omitted, except the "Deutschland's" fine performance of 5 days 7 hrs. 38 mins.

In the year 1905, the Cunard Line floated the "Carmania" and "Caronia," each 675 feet long and over 19,500 tons. These were huge experimental ships, with a speed of 18 knots, yet capable of carrying 10,000 tons of cargo and coal and about 2,600 passengers. The chief interest, however, lay in the engines; the "Carmania" was driven by three turbines working as many screws, while the "Caronia" was propelled by quadruple-expansion reciprocating engines. British hopes were now running high, for on the working of these two vessels would depend the type of ship with which the Cunard Line would attempt to reassert supremacy over the Germans.

In 1907 the Cunarders' reply to the Anglo-American shipping combine and German competition was the sister vessels the "Lusitania" (Plate XXXV) and the "Mauretania" (Coloured Plate D.), the greatest steamships the world had ever seen, and their appearance marked a startlingly new epoch in the annals of merchant shipping. Particulars concerning these vessels will be afforded at a later stage; at the moment we need only deal with their achievements.

The "Lusitania" commenced her maiden voyage on September 7, 1907, and passed Daunt's Rock, Queenstown, at 12.11 p.m. on September 8, reaching Sandy Hook at 8.5 a.m. on September 13, and thus steamed from land to land in the shortest time ever achieved, viz. 5 days 54 min., against the previous best of 5 days 7 hours 38 min., which stood to the credit of the "Deutschland." Really this remarkably fine effort for a maiden passage did not wrest the championship from the Germans, for the "Lusitania" entered New York by a new channel, which effected a saving of five miles; and in point of speed her 23·01 knots per hour had been surpassed by the "Kaiser Wilhelm II." (23·59 knots), "Deutschland" (23·51), and "Kronprinz Wilhelm" (23·47 knots). Nevertheless British hopes ran high, and the vessel's second voyage to the New World was watched with feverish interest. Upon this occasion the "Lusitania" staggered all previous records by steaming 2781 miles in 4 days 19 hours 52 min., at an average rate of 24 knots an hour. Her best day's steaming was 617 knots, eclipsing the record of the "Kaiser Wilhelm II." in this respect by 71 knots; and at some points of the passage the huge liner was forging through the water at a speed of 25 knots an hour.

The British shipping world heaved a huge sigh of relief, for not only was the blue ribbon of the Atlantic once more taken from all rivals, but the "Lusitania" would doubtless improve as her engineers became accustomed to the mechanical and constructional improvements of the new type of ocean greyhound. But in addition to this, her sister-ship was already an assured record-breaker, for in her preliminary trials the "Mauretania" had attained the marvellous speed of 27½ knots or 31¾ land miles an hour.

By the time the "Lusitania" and "Mauretania" were two years old, their earlier successes had become comparatively ancient history, for with ever-increasing speed both had swept the records of their youth remorselessly aside. Let their best performances speak for themselves:—

	Quickest westward passage.				Quickest eastward passage.		
	Dys.	hrs.	min.		Dys.	hrs.	min.
"Mauretania"	4	10	41	...	4	13	41
"Lusitania"	4	11	42	...	4	15	50

The first-named has steamed 676 miles in one

PLATE XXXV.

S.S. "MAURETANIA" IN THE MERSEY.

day, and the "Lusitania's" best day's steaming stands at 666 miles; the "Mauretania's" best average speed is 26·06 knots (September, 1909), and the "Lusitania's" 25·88 knots (March, 1910). Ocean records, however, are notoriously short-lived, and it is more than likely that before the reader sees these figures they will have given way to improved performances.

CHAPTER XVI

SAFETY AFLOAT

DURING the long continued struggle for the championship of the Atlantic, it must be borne in mind that on other ocean routes there was the same stern competition between the vessels of our own rival companies and those of competing nations; and everywhere steamships increased in size with improved steaming capabilities, though not to the same extent as on the Atlantic. The demand for larger and speedier vessels gave an astounding impetus to the British ship-building industry; and for many years even some of the best German steamships were constructed in British yards.

The progress of a ship differs from that of a vehicle on a road, or a train on the rails; her liquid path varies considerably, and she must be forced into and kept in the right direction by steering gear that is at once powerful and safe working. A vessel may have thousands of souls aboard in addition to cargo, great in bulk and in value; and she must possess means of coping with fire, epidemics, etc., that may assail her from within, as well as be prepared for dangers such as storms, darkness, and fog, that may threaten her from without. The ocean-going vessel must be self-contained in all respects, since her voyage is always more or less lonely, and outside assistance cannot be relied upon at any given time. If only because a huge liner may cost anything from about £30 a ton for construction alone, one can easily understand the builders and owners exercising every care within human calculation to keep her afloat; and when to this are added the lives of the passengers and the value of the cargo, their great responsibility is materially increased.

First, we may consider the steps that are taken to render a vessel unsinkable, although in this respect the ocean often sets at naught everything that man's scientific ingenuity can suggest. Take any ordinary tin box, bore a hole in the bottom, and set it in water. In a very short time the water will fill the box and sink it. Now, if a ship's bottom or side be perforated by collision with another vessel, or striking on a rock, exactly the same thing will occur; the water will fill all the numerous divisions and compartments of the vessel and send her to the bottom. The modern shipbuilder, however, seeks to provide the means to prevent such a calamity.

If our tin box had been divided into three compartments, the hole in the bottom would have flooded only one of the divisions; the box would lie heavier in the water but would not sink, thanks to the buoyancy of the two unflooded compartments. By means of bulkhead, watertight doors, the shipbuilder divides the ship into various sections athwartships, each absolutely cut off from the other when once the doors are closed. The water that pours into the vessel from a leak thus need only flood a small portion of the ship, and she can often be kept afloat with comparative ease until the leak can be repaired and the danger averted. Extending the whole length of the vessel is a double bottom, divided, like the rest of the hull, into watertight compartments to afford a constant measure of additional buoyancy.

The doors in the bulkheads must not only be perfectly watertight, but there must be a quick and effective arrangement for closing them, and especially those compartments which are occupied by the engine and boiler plants. There are several kinds of closing gear, the best of which enables the doors to be closed simultaneously and instantly by a device worked from the navigating bridge (Plate XXXVI). There is a system of alarm bells which ring out a warning to all persons in any compartment that is to be closed, so that they may make their exit in good time. In the chart-house on the bridge is a bulkhead indicator with an

PLATE XXXVI.

CAPTAIN ON NAVIGATING BRIDGE, "MAURETANIA."

electric light for each bulkhead door; and as soon as a door is closed the light flashes up, so that at a glance the captain can see which doors are open and which are closed.

The engine and boiler plant of a steamship must be of the most durable and resistive materials, so as to obtain the most perfect order of the machinery. Reserve supplies and implements are usually provided, so that any damaged part may be replaced without any interruption of service. In the case of large boiler plants they are generally arranged in independent sets so that, if a whole engine or group of boilers be disabled, the vessel may still continue the voyage by her own power. Plate XXXVII depicts the starting platform of the "Mauretania," showing the dials that correspond with those under the hand of the navigator on the bridge far above.

The propelling apparatus, the screws and shafting, must exhibit the maximum of strength and durability. The crank shafts in the best and biggest steamers are made of nickel steel, and manganese bronze is frequently used for the propellers. The twin-screw system is generally employed to-day, in which are two independent sets of engines, shaftings and screws, so that if one of the propellers be rendered useless, the ship will still be able to proceed by means of her second propeller.

Besides their main business of propelling, the screws can assist not only in the manœuvring of the vessel, but in a case of emergency can be used for steering purposes. In October, 1907, the "Kaiser Wilhelm der Grosse" fractured her rudder. Although the captain could have made Halifax, only 700 miles distant, he decided to continue the voyage homewards, and reached Bremerhaven, a distance of 2,300 miles, without further mishap. The rudders of steamships used to be made of cast-steel, but nowadays they are chiefly built up of wrought-iron or forged steel, either of which, owing to their toughness and ductility, afford the greatest possible safety against fracture.

The gravest danger that can arise within a ship is an outbreak of fire; and great attention is always paid to the fire-extinguishing plant. The use of electric light instead of the old-fashioned oil lamps lessens the danger of fire considerably; but, in any case, inflammable goods are stored with the greatest care. The coal-bunkers, in particular, call for special ventilation to prevent self-ignition. But no amount of care guarantees absolute safety against an outbreak of fire, and thus throughout a ship is to be found the ordinary hydrant and hose system in connection with steam and hand pumps. Hand-worked fire extinguishers are always at hand for outbreaks in cabins or any other of the passenger apartments. Just as there are self-closing water-tight doors, so there are fire-bulkheads or iron walls at certain intervals athwartships, by means of which a fire is limited to its original seat, and prevented from spreading to other parts of the ship.

A fire in the hold is a very serious matter, and where water and steam fail to overcome it, recourse is sometimes made to an apparatus in which a blowing engine introduces fumes of great extinguishing power. Such an apparatus is also of great service in disinfecting ships after contagious disease, and also in exterminating vermin, insects, rats, etc.

External dangers to a lonely vessel may arise when it is difficult to ascertain its exact whereabouts on the high seas, especially at night or during a fog. Mention has been made of how the steel hull of a vessel affects the compass, which has to be very carefully adjusted, and as much iron as possible kept out of its immediate neighbourhood. There are various nautical instruments at the disposal of the navigator by means of which to learn the altitude and angle of the sun, moon and stars, and to take the bearings of fixed points on the coast, and always a reliable chronometer is essential, so as to secure an accurate computation of the time. Often, however, the weather is such that the vessel can only be steered by the aid of the compass.

The lead and the log are two very important aids to navigation ; the first is used to ascertain the nature of the bottom in shallow waters or the whereabouts of the ship when in close proximity to the coast; while the latter records the speed of the ship. The most modern vessels are fitted with an electric speed indicator by which the captain can ascertain the number of revolutions of the screws and the distance travelled. At night time all vessels carry lights, their colour and position being settled by international agreement. Precise international rules, too, determine the manœuvres necessary for two ships meeting on the same course in order to avoid a collision.

Fog is one of the greatest hindrances and dangers to navigation, for then obstacles are not visible until it is too late, and collision or stranding is unavoidable. In foggy weather the siren is constantly used; speed is reduced; and in waters that are particularly dangerous, the ship is brought to anchor until the fog lifts. Signalling by siren or other sounds is not always reliable; adverse currents of air and differences in the thickness of the fog, often make it impossible to gauge the distance or the direction from which the sounds are coming.

In recent years there has been introduced a submarine signalling apparatus. Water carries sound about four and a half times quicker than air, and neither wind nor waves detract from the sound itself. The main part of the sounding apparatus is a submarine bell attached to lightships, buoys, etc. Most of the better-class passenger steamers have an apparatus fitted within their hulls at the bows. A receiver is placed on each side of the ship, and by their means it is possible to tell whether the lightship or buoy is on the port or starboard side. Such signals are easily audible from a distance of four or five miles, and very often a great deal further; and ships are enabled to keep to their course even in the densest fog. Upon one occasion the "Kaiser Wilhelm der Grosse" was due at Cherbourg, where a tender was lying just outside the harbour awaiting her arrival. The Channel was enveloped in a dense fog, but the tender sounded her signal bell, and the sound was picked up by the liner when fifteen miles from land. Guided by the constant signals, the liner literally felt her way into port, thanks solely to the submarine signalling apparatus.

The latest scientific aid to safety on the ocean is wireless telegraphy. There have been various instances of mishaps afloat, that might have been marked by heavy loss of life but for the Marconi apparatus. One notable occasion was in January, 1907.

The White Star Liner "Republic" (15,378 tons), at that time the largest and fastest steamer in the Boston trade, collided with the Italian Liner "Florida," off Nantucket Island, fifty miles from the American mainland, during a dense fog. The

"Republic" had 461 passengers, and a crew of 300, and the "Florida" carried 800 emigrants, and a crew of 200; two saloon passengers on the former and four of the crew of the latter were killed at the moment of the collision.

Captain Sealby, of the "Republic," was on the bridge when the vessels met. Suddenly a series of whistles came out of the fog. Captain Sealby replied with a danger signal, but before either vessel could slacken speed the "Florida" crashed bows on into the "Republic." The watertight compartments of the liner were closed at once; but after a hurried examination Captain Sealby came to the conclusion that his ship could not long keep afloat. Instantly the signal "C.Q.D.," which means "Help, I am sinking," was flashed from the "Republic's" wireless instruments. This was followed by the vessel's name and particulars of her position.

The signal was received at New York, at the Charlestown navy yard, at the Provincetown naval station, Massachusetts, and by the liners "Baltic" of the White Star Line and "La Lorraine" a French vessel. Later the messages were picked up by the Cunarder "Lusitania," the American liner "New York," the Anchor liner "Furnessia," and the Ward liner "Seneca." Tugs and revenue cutters were rushed out from New York and from various other ports along the coast.

As the condition of the "Republic" seemed to be most serious, it was decided to transfer her passengers to the "Florida," and this was almost completed when the "Baltic" arrived; but when the Italian vessel started for New York, it was speedily evident that she was damaged too seriously to undertake the task; and eventually all the passengers were transferred to the "Baltic," which conveyed them to New York.

General Ives, who was a passenger, said that he did not believe history records any parallel for cool conduct and discipline in the face of such trying circumstances. There was no rush for the boats, and it made one proud to be an Anglo-Saxon to see the English and American women come up the "Baltic's" side, all with smiling faces.

On the "Florida" a panic ensued, that was only quelled when second-steward Spencer of the "Republic," who is only a small man, jumped among them, and using only his fists, knocked down man after man. He soon had the emigrants cowed, and then he announced through an interpreter that he would throw overboard the first man who misbehaved.

John Binns, the Marconi operator, worked his apparatus for fourteen hours in the darkness after the office had been swept away, sending calls for help in all directions until the storage batteries gave out. He had the unusual distinction of being eulogized in Congress. In the House of Representatives, Mr. Boutelle, one of the leading orators of that assembly, stirred it to enthusiasm by describing Binns as a man whose example had a lesson for humanity. In conclusion, he said that "the one silent actor in the tragedy had given to the world a splendid illustration of the heroism that dwells in many who are doing the quiet, unnoticed tasks of life. Is it not an inspiration for all of us to feel there are heroes for every emergency, and that in human life no danger is so great that some Jack Binns is not ready to face it?"

However well-found a ship may be, and however well provided with safety appliances, it is sometimes necessary to abandon her, while yet many miles from land and no other vessel at hand to render assistance. With this contingency in view it is necessary to provide a ship with lifeboats, lifebuoys, and lifebelts. The material of which they are composed, their construction and distribution, are matters that are not left to the discretion of the shipowners; the authorities of different countries prescribe detailed regulations that are rigorously enforced. All life saving appliances have to be examined at stated intervals, and defective articles have to be replaced by others in perfect condition. Particular attention is paid to the boats, and boat-drill is engaged in regularly, so that when circumstances demand it, the passengers

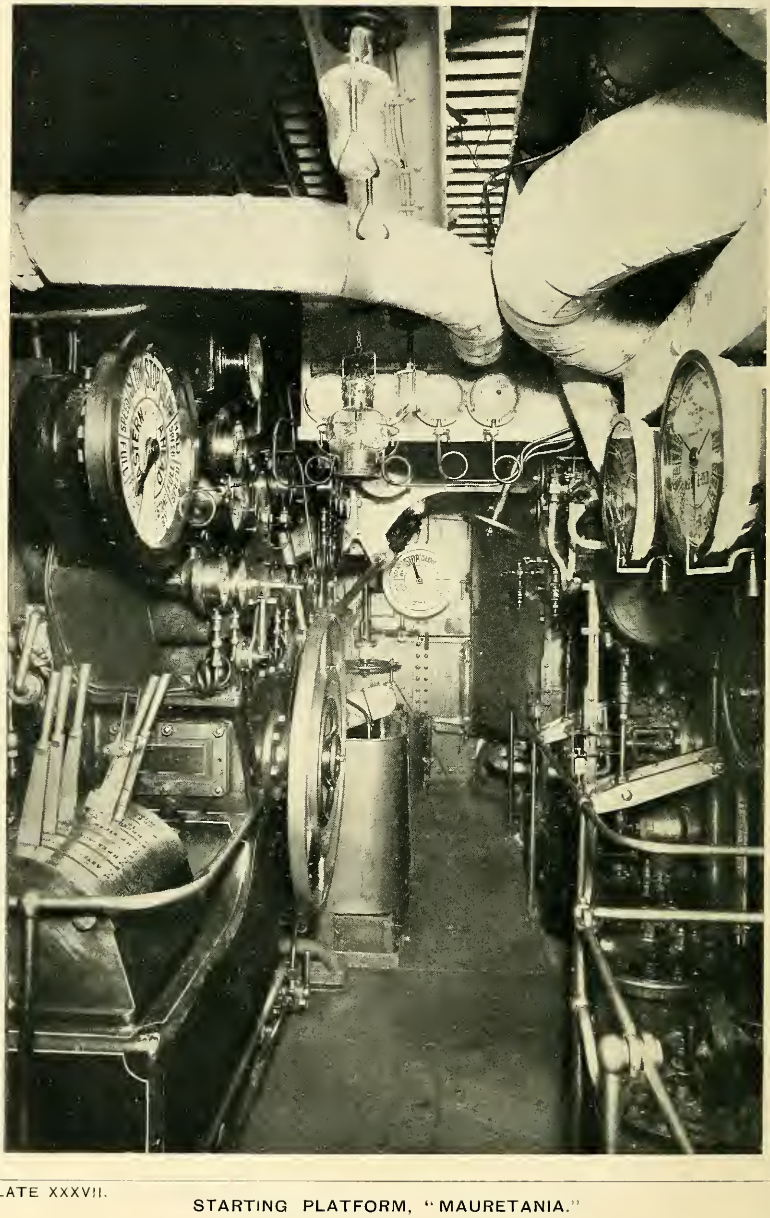


PLATE XXXVII.

STARTING PLATFORM, "MAURETANIA."

may be easily and quickly lowered from the davits.

All large liners now carry a powerful electrical lamp by means of which to light their path at night time, and enable the look-out to detect rocks, icebergs, and derelicts. This lamp, called the searchlight, is usually fixed on the bridge; it is backed with a peculiar-shaped mirror from which is reflected the dazzling light of a continuous shower of electrical sparks. The searchlight is invaluable in such cases as a "man overboard," assisting ships in distress, and also renders excellent service in signalling according to a recognized code of flashes. Electric arc lamps, suspended over the deck, provide sufficient light for vessels to coal or unload during the night, thus effecting a great saving of time.

But even the provision of the best safety devices ever conceived would prove of little value in a case of sudden emergency, unless arrangements are made for their prompt and effective use. Before any Cunard vessel commences a voyage—and the same may be said of practically every well-known shipping company—a thorough examination of ship and crew is made by reliable and responsible officials. The men are mustered and exercised in boat drill, fire drill, and pump drill; heed being taken that every man knows his proper position and the exact extent of his duties, so as to avoid panic or confusion in the event of sudden emergency. An inspection is made of the storerooms, rockets and other signals are critically examined, and the doors of the watertight compartments are shut and tested. An exhaustive code of instructions is compiled for the use of captains, officers, engineers and every man on board, plainly stating their individual duties, and laying down distinct rules for their guidance under all circumstances.

CHAPTER XVII

LIFE ON A LINER

ON July 4, 1840, the "Britannia," the first Cunarder, left the Mersey for the New World; she carried 115 cabin passengers and 225 tons of cargo, for she was only 207 feet long with a tonnage burden of 1154. A present-day liner, not by any means the largest, will have a thousand passengers and several thousand tons of cargo; and is well described as a floating city or an ocean palace, forming a medley little world of people, with all their hopes and fears, collected in the narrow confines of one vessel.

Let us in imagination betake ourselves to the "Mauretania" or "Lusitania" in mid-ocean, when the giant engines are thrusting the ship forward three times her own length every minute. First try to gain a practical notion of the immense size of the vessels, which, when built, were the largest in the world; but by the time they were four years old were surpassed in bulk by the White Star leviathans, the "Olympic" and "Titanic."

DIMENSIONS OF THE "LUSITANIA" AND "MAURETANIA."

Length	790 feet
Breadth	88 „
Depth	60 „
Draught (fully loaded)	37 „ 6 ins.
Registered tonnage	31,500
Displacement of load draught	45,000 tons
Horse-power of turbine engines	68,000
Height to top of funnels	155 feet
Height to mastheads	216 „
Passenger accommodation, 1st class	500
„ „ „ 2nd „	500
„ „ „ 3rd „	1,300
Crew	800 to 900

The exact meaning of some of these dimensions will be more clearly realized by comparison. If the "Lusitania" could ascend the Thames and be anchored in front of the Houses of Parliament very little of the noble frontage to the river would be visible except the towers that extend above the main roofs of the buildings; while if the Capitol, Washington, were placed in front of the Cunarder, the historic building would not block out the length of the vessel, and even the great central tower would only partially hide a couple of the funnels. The Brooklyn Suspension Bridge is the largest suspension bridge in the world; the central span is 1595 feet in length, and the height at the centre is 135 feet above water-level. The funnels of either of the sister vessels are 155 feet above the furnaces; and the two vessels placed end to end across the channel would completely close the waterway under the bridge.

It must be understood that most of the following remarks are particularly applicable to the Cunard leviathans; but, except for size, they apply equally well to almost any well-known liner afloat, not only on the Atlantic, but on the other great ocean routes.

The "Mauretania" has five stokeholds, in which are twenty-five boilers, of which all but two are double-ended. A locomotive boiler is fired by means of one furnace, but twenty-three of these boilers have eight furnaces each, four at each end, and even the single-ended couple has two furnaces each. There are thus no less than 192 furnaces, which require the constant attention of the firemen, of whom there are 204, working in watches of four hours each, so that no man spends more than eight hours out of the twenty-four in one of the most arduous tasks in which men can engage.

Each grimy, sweltering watch shovels into the blazing fires no less than 220 tons of coal, or 1320 tons a day in all. Look at the smoke belching from the four funnels, and cease to marvel that each of these huge stacks is 60 feet in circumference. If one of the monster cylinders were laid down, say, in Argyle Street, Glasgow, the electric trams running on their double track would be able to pass through the tube with ease.

There are 6600 tons of coal on board, which means the contents of twenty-two trains of thirty trucks, each truck containing ten tons of fuel. Such an immense weight requires careful handling, for any irregular displacement would interfere with the equilibrium of the vessel. To guard against this, a large number of trimmers are constantly employed. They see that the coal in the bunkers is kept in position, and constantly wheel supplies of fuel to the furnace doors, where the firemen, bare to the waist, are shovelling as if for dear life.

Firing a boiler, whether it be on a locomotive or down in a stokehold, is not merely a haphazard business of filling the furnace's hungry maw. When the door is opened and the flames shoot out, threatening to lick up the man intent upon feeding them, his practised eyes must detect where the fire is thinnest, and where combustion is being checked. With a long iron rake the man cleans the whole of the glowing mass, or breaks up an obstruction with a thick iron "pricker," in the process enveloping himself in a shower of sparks that would prove terrifying to an ordinary mortal. But the perspiring demon recks not of singeing, especially if the vessel is record hunting.

The whole heating surface of the boilers is 159,000 square feet, or forty-five times that of the biggest locomotive boiler yet built; but then the "Mauretania's" horse-power is 68,000, with which to turn the four propellers that push an enormous dead weight, not through air, but through water, and often in the teeth of a gale, when both wind and water doubly oppose themselves to the vessel's progress.

Endeavour to measure the work done by the engines. Sixty-eight thousand horses placed head to tail in a single line would extend ninety miles, as far as from London to the Isle of Wight, while, if the steeds were harnessed twenty abreast, there would be no fewer than 3400 rows of powerful horses. One horse-power as applied to machinery is equivalent to the exertion marked by the raising of 33,000 lbs. one foot in one minute; but, as a horse can exert such a force for only six hours in the day, one machinery horse-power is in reality equal to the power of more than four horses. The actual horse-power of any engine is thus from three to five times the nominal horse-power.

In the earlier chapters references have been made to the continual changes in marine propulsion, the abolition of paddle-wheels for the screw, the compounding of engines, and the introduction of the turbine. The "Great Eastern's" paddle-wheels revolved only eight times per minute. Their bulk, especially with the great covering-boxes, was so great, that the heavy waves in a rough sea not only bent the floats, but threatened to tear the wheels out of the ship's sides, and for safety they would often be brought to a standstill. The very dependable and speedy screw, driven by expansive engines, or the latter-day turbine, has its work chronicled in the speed records on the various ocean routes.

The great Cunarders are each furnished with four screws, the wing shafts, or outermost pair, being driven by two high-pressure turbines, and the inner shafts by the low-pressure ones. Attached to each of the inner shafts is a high-pressure turbine for reversing purposes. These reversing turbines revolve even when the vessel is going ahead, but of course are no aid to progress. We must content ourselves with giving a photographic view of an engine-room, for to describe the maze of machinery would take up too much space, and would be altogether too technical for our present purpose. The firemen and trimmers have already been mentioned; the engineers number thirty-six, and there are almost exactly as many greasers.

In addition to the propelling machinery, there are quite three-score auxiliary machines of one kind or another on board, such as the electric lighting dynamos, refrigerating engines for keeping cool the chambers in which are stored the meat, fish, and fruit required on the voyage, ash-hoists for raising ashes from the stokehold to be dumped overboard, or another ingenious apparatus that discharges the ashes out of hoppers by a stream of water. From end to end of the vessel are pumps galore, for service in case of fire or foundering, and to supply the labyrinth of pipes with water for the purely domestic services of the ship.

Now we will turn to the navigating staff. In addition to the captain and his six officers, there are forty seamen and another score of men ranging from the six quartermasters down to the lamp trimmer. The steering of the vessel falls to the quartermasters. On a sailing vessel the man at the wheel often needs sheer brute strength to turn the tiller in the required direction; but the helm of a great ocean liner is moved from side to side by a steering engine, to which the quartermaster admits steam by means of the quite small steering wheel under his hand. If, however, it should happen that from any cause the steam fail, there are a couple of hand wheels, that would call for the united services of four men.

The able seamen, superintended by the boatswain and mates, do not find time lagging on their hands, for their duty is to keep the deck spick and span, and particularly to see that the lifeboats are in order and ready at short notice to be lowered from their davits. Two seamen are always employed in the "look-out" in the "crow's-nest" high up on the foremast, from which they can easily telephone to an officer on the bridge. The modern mast is a hollow cylinder composed of steel plates, in which is inclosed an iron ladder, by means of which the look-out man can gain his high perch without using the ratlines of the rigging.

The signalling arrangements on board ship are of vital importance, for, unlike the railway train, the vessel must signal for herself. Signalling by flags is an old method that is still followed by ships all the world over; and thus by means of the international code, two captains of different nationalities will converse freely, whereas in a personal interview they would need the services of an interpreter.

By means of her steam whistle, or siren, a vessel can speak with no uncertain voice in the matter of general warnings. One short blast intimates that the vessel is about to be directed to starboard, and two blasts that she is being directed to port, while three short blasts signify going full speed astern. The rule of the road at sea is that all vessels meeting end on keep to the right, and that when they are crossing each other's path, the one that has the other on its starboard, or right side, must give it precedence. These rules are comparatively easy to keep in clear weather, but in fog or thick squalls they are practically useless; and then, not only does the siren give a long blast about every two minutes, but often rockets and flares are called into requisition.

We have read of the usefulness of wireless telegraphy as a life-saving device, but the wireless apparatus is constantly rendering other useful service. This wonder of the age enables communication to be kept up with the land or other vessels hundreds of miles away. While nearly a day's steaming from a port of call such as Queenstown, Plymouth, or Fishguard, the captain of a liner can announce to the port officials, not only his arrival almost to a minute, but the number of passengers and the number of mail-bags for which a boat-train is to be in readiness. On many of the Atlantic leviathans the passengers are supplied with news while crossing the ocean. In the case of the Cunard boats the news messages are published in the *Daily Bulletin*, copies of which are published at breakfast-time, just as the daily newspaper is ashore. These messages are flashed from the telegraphic stations in the British Isles or the United States, according to the position of the vessel; and it has frequently happened that a ship has received her news when over 2000 miles from the sending station. In cases where life and death or huge business interests are at stake, it can be imagined what a boon wireless telegraphy proves. Sometimes the passengers on two liners, hundreds of miles apart, engage in a chess match, the various movements of the players being transmitted by the Marconi operators.

The ship's doctor—and the largest liners carry two and even three medical men—is a very important personage in a floating city; he might more fittingly be called the Medical Officer of Health, for in addition to attendance upon sick members of the passengers and crew, he is responsible for the sanitary arrangements of the vessel. Sea-sickness has been greatly ameliorated by the large dimensions of modern ships. Owing to their great length they now rest upon two waves instead of one, and consequently there is less pitching and tossing; and rolling is diminished by the greater width of vessels, and by the provision of bilge keels and wing tanks. There are tanks not only in the bottom and peak of a vessel, but also along the sides of the ship, and when filled with water they assist in giving the ship an easy motion in a sea way.

Contagious and suspected diseases are at once isolated in one of the ship's three hospitals; two are for ordinary complaints, and one for infectious cases; but the doctor, subject to the approval of the captain, can claim any vacant cabin for the use of a patient. Steerage passengers are medically examined before coming aboard, and they receive special attention during the voyage; this precaution is necessary owing to the steerage passengers living together in larger numbers in one compartment. The doctor has trained sick

PLATE XXXVIII.

FIRST-CLASS DINING SALOON, "LUSITANIA."

berth attendants to assist him, and special sick berth stewardesses wait upon sick women and children.

The purser is an official whose duties are particularly varied. He appears to be factotum in general to the passengers, who pay to him their bills, leave in his charge any valuables they may wish to be taken care of, hand in and receive their letters, etc. But the purser and his staff are also responsible for all the ship's own accounts, especially in connection with payments which she has to disburse at ports of call.

We have hitherto been reviewing chiefly only the work of some 450 men, whose duty it is to see that the vessel crosses the ocean from land to land; but the personal or domestic side of the "Mauretania" or "Lusitania" calls for the employment of quite as many pairs of hands. Two thousand three hundred passengers and a crew of nine hundred are equivalent to the entire population of more than one cathedral city at home, and their every reasonable want, not only receives scrupulous attention, but is even anticipated as far as possible.

The officials who come most in contact with the passengers are the stewards, of whom there are over 350, together with a dozen stewardesses. Every day three or four thousand persons have to be supplied with meals at specified hours, not only with despatch but in a manner calculated to please.

In olden times, passengers on board ship had to be content with salted meat and hard tack, whereas nowadays the victualling system and culinary arrangements are not excelled in any first-class hotel. Every passenger vessel has its own kitchen and bakery; and it is no exaggeration to say that many steerage passengers fare better during their stay on board ship than at any other time in their lives. Even in the steerage, salt meat is never used, and there are soup, fresh joints, vegetables and puddings for the midday meal, coffee and tea in the morning and afternoon, and soups or another warm dish, fresh bread and butter in the evening.

The steam bakery on board is fitted up in conformity with the most modern systems; even the dough kneading is done by machinery. In the first- and second-class saloons the cuisine would fill an old-time voyager with envy. Quite a score of different kinds of warm dishes, besides tea, coffee, cocoa and chocolate, must, as a rule, be prepared for breakfast on the modern express passenger steamer; the luncheon will comprise two or three different soups and a dozen warm dishes, four or five vegetables, and a varied supply of cold dishes. The dinner will consist of perhaps a dozen courses.

The work of preparing food and beverages for a large number of passengers demands mechanical contrivances worked by steam or electric-motors. Tea and coffee are made by specially constructed apparatus; and egg boilers, ham-cutting machines, plate warmers and refrigerators are only a few items in the kitchen and pantry and store arrangements.

In the refrigerating chambers are stored meat, game, fish, fresh vegetables, fruit, butter, etc.; and even in a long voyage passengers are catered for with almost as much convenience as on land. The "Mauretania" or "Lusitania" before commencing a voyage will take into store 40 tons of potatoes; 4000 lbs. fresh fish; 200 boxes dried fish; 40,000 eggs; and 2000 head of poultry. To supply the meat and bacon practically uses up a herd of 40 oxen, a flock of 100 sheep and a drove of 130 pigs; and large quantities of game vary according to the season.

This chapter may very well conclude with some brief descriptions of the dwelling apartments provided for passengers in these days of almost ultra comfort and luxury. The term "floating palace," applied to a modern express passenger steamship, is not a misnomer, though unlike many palaces, the magnificence of any vessel is always subordinated to practical utility and comfort.

The 500 first-class passengers on board the "Lusitania" or "Mauretania" are accommodated in

260 rooms, mostly of two berths each; they have access to five decks, communication between which is given by two electric lifts and numerous staircases. On the boat deck are situated most of the public rooms, including a writing-room, library, lounge and verandah café. The promenade deck is mostly taken up with state rooms and two "regal suites," each with dining-room, drawing-room, two bedrooms, servants' room and bathroom. Below, on the upper deck, is a children's dining saloon and nursery. The main dining saloon (Plate XXXVIII) is on the next deck; it is the full width of the ship and is 86 feet long, or practically square; and the beauty of its ornamentation makes the visitor doubt whether he can be on board a ship at all. A number of first-class state rooms are on the main deck, which has an entrance at a convenient level for gaining access to the ship from a tender.

The state rooms are as spacious and well fitted in their way as the public rooms. A constant supply of hot and cold fresh water is laid on. This luxury means an enormous amount of plumbing work, as well as no inconsiderable addition to the coal bill, for it necessitates the installation of condensing machinery with a capacity of 400 tons of fresh water a day.

The second-class passengers, accommodated aft of the first, enjoy comfort not inferior to that of first-class passengers on many vessels that are by no means out of date; and third-class passengers have a large dining-room with revolving chairs, lounge, etc., and a generous amount of promenade space.

There is scarcely any large vessel afloat that does not possess some apartment or other either of special magnificence, or showing some marked departure from general practice.

A voyage across the Atlantic occupies less than a week, whereas the passage to the Cape takes fourteen days, and from London to Adelaide a full month. It is in these longer passages that the comforts of a liner are tested to the utmost, and where special efforts are necessary to prevent monotony and weariness. Children's saloons are an immense boon to young travellers. On the vessels of the Royal Mail Steam Packet Company, for example, the walls of these apartments are decorated with pictures, fanciful and humorous, with titles painted on them in English, Spanish and Portuguese (Plate LV). One such picture shows one of the "wise men of Gotham" at sea in his bowl, which he paddles vigorously with his shovel.

Ample deck space is usually a marked feature of the long-distance liners. On the "Kinfauns Castle" the promenade, poop and upper decks are sheltered in bad weather by nettings to break the force of rough seas, and by side screens; which precautions are taken on all large passenger vessels. Some idea of the dimensions of the ship—and it is only half the tonnage of many Atlantic liners—may be gathered from the fact that a walk half a dozen times round the promenade deck means about a mile.

Many other features of life on board ship must be left to incidental reference in describing different vessels that plough the various ocean routes.

CHAPTER XVIII

THE ATLANTIC FERRY

Part I

BEFORE proceeding to the main business of this chapter we may take a brief review of the world's steamships, of which a very great number, and especially the largest vessels, are concerned with the North Atlantic trade. There are no less than forty-nine shipping companies that each own steamships aggregating more than 100,000 registered tons, and of these companies thirty-one are British. The largest steamship companies in the world in the order named, are: Hamburg-American; Norddeutscher-Lloyd; White Star; British-Indian Steam Navigation Company; Peninsular and Oriental Steam Navigation Company; A. Holt; Elder, Dempster & Co.; Furness, Withy Co.; and Ellerman Lines. The Cunard Line is only nineteenth on the list of largest steamship owners.

Roughly speaking there are only about 260 ocean-going steamers in the world that are capable of steaming at 16 knots an hour, and of these 120 are British. There are quite 1750 steamers capable of 12 knots or more, of which more than half are British. Only about 30 vessels can steam 20 knots and upwards, of which thirteen fly the British flag. The world's total steam tonnage is about 3,700,000, of which we claim almost exactly half. In the last year for which figures are available the new merchant steamships launched all the world over numbered 523, with a tonnage of 929,000; of these 301 were built in the United Kingdom and 74 in the British Colonies, aggregating 622,000 tons.

The Atlantic is by far the most important ocean in the world, because the most valuable lands from an economic point of view, slope towards it, the lands inhabited by the most energetic peoples. The North Atlantic is the busiest shipping thoroughfare, and our own trade returns show its outstanding importance. From Canada we draw vast quantities of corn and flour, wood and wood products, live animals, and dairy produce; and the United States supply us with raw cotton, grain, animals, meat, timber, petroleum and many other products. The amazing rise in American trade is one of the wonders of the modern commercial world; and out of 77,000,000 tons of shipping entered and cleared from the ports of the United States in a year, only 10,000,000 tons are in connection with the Pacific coast. Again, North

PLATE XXXIX.

MAIL TENDER ALONGSIDE THE "MAURETANIA."

America draws to its swelling prairies settlers from every country in Europe. From British ports alone in a single year sail some 550,000 emigrants, of whom about 170,000 are Britons bound for the States and 150,000 for Canada; the remainder are foreigners who come to England to take advantage of the cheap steerage facilities offered by numerous British shipping companies.

The Cunard Line is a household word, not for the number of its ships or the immensity of its tonnage, but the manner in which it has upheld the supremacy of British shipbuilding, and particularly for its determination not to allow a foreign company to claim the speed honours of the Atlantic passage. By the time these words appear in print the great Cunard steamships will have been surpassed in size, but history seems likely to repeat itself, for in the autumn of 1910 it was announced that the Cunard Company had determined to build the largest steamship ever constructed, probably approaching 1000 feet in length, and with a tonnage in proportion.

The marine engineer's vocabulary does not contain the word "finality." Ever since the days of the "Comet" there has been continual progress, marked at different periods by some almost startling deviation from ordinary practice. It is now evident that we are destined to see ships altogether different in type from any yet floated upon the waters, for they will have no funnels and boilers, and the services of stokers will not be required. It is practically certain that the engine of the future for marine purposes will be the oil internal combustion engine. The fact that the Hamburg-American Line has built a 9000-ton motor-driven liner shows that the oil-engine is seriously challenging the supremacy of steam.

The present-day Cunard fleet consists of over a score of vessels aggregating 230,000 tons. In the Liverpool to New York service the five chief vessels engaged are the "Lusitania," "Mauretania," "Caronia," "Carmania," "Campania." The size and speed and various other particulars of these vessels have already been given, but their points of interest are by no means exhausted.

When the "Campania" appeared in 1893, one wondered whether it was really possible for the shipbuilder ever to improve upon his latest effort. Her dimensions alone were viewed with wonder: length, 601 feet; beam, 65 feet; registered tonnage, 12,950. The engines developed 30,000 horse power, affording a speed of 22 knots. In view of the likelihood of the vessel being used as an armed cruiser, the rudder and steering gear were placed completely under water, so as to minimize the risk of disablement by being struck by projectiles. Up to this time only the "City of Paris" (Inman Line) could boast of similar construction.

Twelve years passed away during which other steamers, that showed the shipbuilders' tireless energy, made their appearance. The Cunard Company floated the "Caronia" and "Carmania" each 650 feet by 73 feet by 40 feet, and a registered tonnage of nearly 20,000. These two vessels were particularly noticeable for their magnificent accommodation. The increasing size of passenger ships gave more scope for securing the comfort of the passengers; and the state rooms and saloons were replete with all kinds of innovations to add to the comforts of travel.

The Cunard leviathans, the "Lusitania" and "Mauretania," showed even a more marked advance concerning the comfort of the passenger; and the public and private rooms, kitchens, etc., are certainly not surpassed by any hotel ashore. There are smoke-rooms, lounges, verandah cafés, libraries and writing rooms, orchestras, daily newspapers, telephones in the state rooms, and electric lifts to convey passengers from one floor to another. There are spacious promenades, cosily seated entresols, and last, but not least, a cuisine replete with all the delicacies of the season, to meet the varied tastes of the cosmopolitan travellers who cross the Atlantic. Concerning the internal decorations of some of the main apartments, one illustration must suffice, but in later pages something will be said about the elaborate decorative schemes of various famous liners.

From the end of March to the beginning of September the five Cunard vessels named give a passenger a choice of six dates in the month for sailing; and he will be carried from any railway station in the kingdom to Liverpool, and then to New York, a distance of over 3000 miles, for any sum ranging from £19 to £6 15*s.*, according to the boat and the class he selects. Transference from the Old to the New World need not cost the voyager more than about a halfpenny per mile, and even against this he can place the cost of his board and lodging for the greater part of a week.

In the Company's Boston service the two chief vessels employed are the "Franconia" and "Ivernia," ships of moderate speed, but remarkably steady in all weathers. The dimensions of the latter are: 582 feet by 65 feet by 38 feet; 14,067 tons; speed, 16 knots. Her sister vessel, the "Saxonia," is practically the same in all respects. Each of them is fitted with electric light, wireless telegraphy, refrigerating machinery, and submarine signalling apparatus.

The latest addition to the Cunard fleet is the twin-screw "Franconia," which was launched in July, 1910: length, 625 feet; breadth, 72 feet; gross tonnage, 18,000. Though not so large as the express steamers "Mauretania" and "Lusitania," the new vessel embodies many features that place her in the front rank of modern steamships. No

PLATE XL.

WHITE STAR S.S. "BALTIC."

larger boat has yet entered Boston harbour. The vessel is driven by direct-acting, quadruple-expansion engines giving a speed of $16\frac{3}{4}$ knots. The propellers are four-bladed and are made of manganese bronze. There is storage for 1500 tons of fresh water, and a couple of distillers can produce an additional 90 tons of fresh water per day. All the apartments for the use of passengers are fitted up to secure the highest degree of comfort and convenience. From the time the vessel's keel plates were laid to making her first voyage in the early part of 1911 occupied little over fifteen months, which is something like record time for so large a vessel.

The Cunard vessels have adopted Fishguard Harbour as a port of call on the eastward passage, representing a considerable saving of time for those passengers whose destination is London or the Continent. Leaving New York on Wednesday, the "Lusitania" or "Mauretania" arrives at Fishguard about noon on Monday. The Great Western Railway Company have fitted out special tenders to carry the passengers from the liner to the quay, where the train is in waiting, and the Customs and Postal officials are in readiness to deal with the luggage and mails (Plate XXXIX).

The Great Western Railway Company long ago recognized the unique advantages of Fishguard, and several millions sterling have been spent upon the new harbour works to meet the requirements of mail and passenger steamers. The following table shows the distances between New York and the principal British Atlantic ports :—

New York to	Fishguard direct	...	...	2929 miles
„ „	Plymouth „	...	...	2978 „
„ „	Liverpool „	...	...	3051 „
„ „	Southampton „	...	...	3076 „

Compared with Liverpool, therefore, the saving in distance to Fishguard is 115 miles, and owing to the slackening of speed when in the Mersey the time in covering the distance is considerable.

In the American and Hungarian service the Cunard Line employs various twin-screw passenger steamers, such as the "Carpathia," "Pannonia," and "Ultonia." The first-named is the largest: 540 feet by 64 feet by 38 feet; 13,600 tons; 15 knots. The second is 9851 tons register and 14 [illegible] knots; and the "Ultonia" is 10,400 tons and 13 knots. In winter the larger vessels, "Saxonia," "Caronia," and "Carmania" also work on the route from New York to Fiume, *viâ* Madeira, Gibraltar, Genoa, Naples, Alexandria, and Trieste. This increased service is necessary to cope with the large number of American tourists, who visit the warm Mediterranean while their own country is experiencing its coldest weather.

The White Star Line played no unimportant part in the struggle for the blue ribbon of the Atlantic, and several of its vessels will ever remain notable in shipping history. During recent years the new vessels have been marked by an increase in size, with every possible convenience for passengers, and a high rate of speed only little short of speed championship honours. It is a remarkable fact that all the White Star vessels, excepting only the "Cretic," have been built by Messrs. Harland and Wolff, of Queen's Island Yard, Belfast. The following are a few points connected with this famous line.

With the exception of the "Olympic," "Titanic" and "Laurentic," which are triple-screw vessels, all the Company's steamships are twin-screw, and their average tonnage is by far the largest of any shipping fleet in the world. Many improvements that are now common on all big liners were originated by the White Star management, such as placing saloon and passenger accommodation amidships, the adoption of electric bells, self-acting water-tight doors, and supplying third-class passengers with bedding, eating, and drinking utensils, instead of compelling them to provide their own. For Scandinavian third-class passengers there are Scandinavian cooks; for Hebrew passengers there are Hebrew cooks and Kosher kitchens; and for first-class passengers fully equipped Turkish baths are at their disposal.

In the White Star Southampton-Cherbourg and New York service, *viâ* Queenstown (westbound) and Plymouth (eastbound), are engaged the "Adriatic," "Oceanic," "Majestic," and "Teutonic." The first "Adriatic" (1872) was only 452 feet long and 3887 register tons, carrying 869 passengers. She was considered a marvel in size and appointments, and it must be remembered that vessels much smaller are rendering excellent service on all the great ocean routes. Nevertheless the first "Adriatic" was only a toy compared to her namesake of to-day, which is a floating palace 726 feet by 75 feet by 50 feet; 25,000 tons, speed 18 knots and accommodation for 3000 passengers. Passengers must eat, sleep, lounge, walk, talk and enjoy themselves on board a modern vessel, where an attempt is made to serve every taste and meet every want. Two magnificent apartments are shown on Plate XLI. A whole chapter might easily be occupied in describing the "Adriatic," in the building of which 20,000 plates and two and a half million rivets were used. Her anchors weigh eight tons each, worked by powerful machinery, and held by cables $3\frac{5}{8}$ inches in diameter and 90 tons in weight. The vessel has nine steel decks and twelve watertight compartments. There is a gymnasium for those who care for physical exercises, a dark room for photographers, and a skilled orchestra gives

PLATE XLI.

FIRST-CLASS READING AND WRITING ROOM, S.S. "ADRIATIC."

FIRST-CLASS DINING SALOON, S.S. "ADRIATIC."

performances at regular intervals during the voyage.

The "Oceanic" is 704 feet long and 68 feet broad; 17,274 tons register and speed 21 knots; the "Majestic" and "Teutonic" are smaller vessels, 10,147 tons and 9984 tons respectively, and both with a speed of 20 knots.

The first-class dining saloon of the "Oceanic" is capable of seating 358 persons, and is the most artistic feature of a vessel on which there is everywhere a sense of spaciousness, airiness, luxury and comfort. The apartment is lighted by means of a dome, the decorations of which reflect the greatest credit upon the artist. The ceiling, which is panelled out in deep coffers, with richly gilt cored mouldings in them, cannot pass unnoticed; nor yet, again, the handsome screen of carved oak, with its panels of glass defended by rows of beautiful candelabra-shaped columns. The carpets are woven from old examples, and the electric lighting is entirely from above, *i.e.* from the ceiling panels and from the ribs of the dome.

In 1907 the White Star Line decided to remove its Royal and United States Mail Service from Liverpool to Southampton, so as to afford its patrons the choice of embarking or disembarking either at a French or English Channel port.

Though the size of a vessel no longer has the same significance that it once had, the shipping world was certainly stirred when it was announced that it had been decided to construct two White Star liners that would secure the world's record for size, and, indeed, in that respect they were to be worthy of the names "Olympic" and "Titanic." On October 20, 1910, the former was launched from Messrs. Harland and Wolff's yard, Queen's Island, Belfast, a veritable leviathan such as the world had hitherto not seen. Here are some of the dimensions of the new vessel (Coloured Plate E) :—

Length over all	882 feet
Breadth over all	92 ,,
Height	105 ,,
Height of funnels	81 ,,
Top of funnel to keel	175 ,,
Number of steel decks	11
Gross register	45,000 tons
Displacement	66,000 ,,

Among special features that make her one of the wonders of the sea are the restaurant, swimming bath, gymnasium, racquet court, verandah café, and palm court. Never have passengers travelled the ocean amid such luxurious surroundings. The vessel provides accommodation for 2500 passengers and her working crew numbers 860.

Only a very few years ago a vessel of such proportions would have been considered a prodigy, that could only exist in dreams, or the fantastic tales of the "Arabian Nights." "To-day this latest victory of the shipbuilder floats proudly on

PLATE E.

WHITE STAR LINE R.M.S. "OLYMPIC."

The largest vessel in the world—882 feet long, 45,000 tons gross register and 66,000 tons displacement. Launched October, 1910; maiden voyage June, 1911.

the water, a monument to the enterprise of her owners, the faith of her builders, and a prophecy of the continued vitality and progress of an Imperial race, whose ships encircle the globe, enrich the world with the treasures of industry and commerce, and bring the whole human family into peaceful relations and friendly intercourse."

Although the "Olympic" is the largest vessel ever built, she is very graceful, and it is only by contrast with other ships that her magnitude can be appreciated. From keel to truck she is as perfect as human ingenuity and skill and the most powerful appliances can make a vessel. The double bottom, extending the whole length of the vessel, the massive beams and close framing, the large sheet plates, the steel decks and watertight bulkheads, combine to make a structure of exceptional strength and rigidity. In the complete ship there are something like three million rivets, weighing about 1200 tons.

The following particulars will also be found interesting:—The largest sheet plates are 36 feet long, weighing $4\frac{1}{4}$ tons each; the largest beam 92 feet long, the weight of the double beam being 4 tons; the stern frame weighs 70 tons; the rudder 100 tons; the engine crank shafts 118 tons each; bedplate 195 tons; and the wing propellers each 38 tons. The castings for the turbine cylinder weigh 163 tons, and for the centre (turbine) propeller, which is of solid bronze, 22 tons. The great anchor is $15\frac{1}{2}$ tons in weight, and each cable link, about 2 feet long, weighs $1\frac{3}{4}$ cwt.

The machinery of the "Olympic" and her sister ship "Titanic" is the combination of reciprocating engines with a low-pressure turbine so successfully adopted in the "Laurentic." This arrangement is quite satisfactory from an engineering point of view and beneficial to the passengers, largely eliminating vibration, and thus securing the utmost comfort by the smooth working of the ship.

The "Olympic" and "Titanic" will hold pride of place not longer than a few years; for scarcely was the "Olympic" launched than the Cunard Company decided to add to their fleet a vessel that would not only be bigger, but would surpass it in speed, and in that respect would equal if not exceed the speed of the "Mauretania" and "Lusitania"; and a giant German liner was already under construction.

The reader may wonder why some of the great shipping companies trading to other parts of the world do not build such huge liners as are seen on the Atlantic ferry. The size of the vessel is really determined by the trade between countries that vessels serve; but, it must also be borne in mind that many of the foreign ports of call would be unable to accommodate vessels of such deep draught. The "Lusitania" and "Mauretania"

PLATE XLII.

1. WHITE STAR S.S. "LAURENTIC." 2. FIRST-CLASS STATEROOM.

can only enter or leave Liverpool during twelve hours out of the twenty-four; and as it is absolutely certain that the future of the New York trade lies with the forty or fifty thousand-ton vessels, the Mersey Channel will have to be dredged deeper, or the big shipping will gravitate to other ports. Southampton Dock authorities have long been awake to this fact and have made provision in this respect.

The White Star Liverpool to New York passenger steamers are the "Baltic" (Plate XL), "Cedric," "Celtic," and "Arabic," with an average tonnage of over 20,000 gross register. In the Liverpool to Boston service are the "Zeeland" (11,095 tons), "Cymric" (13,096 tons) and "Romanic" (11,394 tons). The Liverpool-Quebec and Montreal route is served by the "Laurentic" (14,900 tons) and "Megantic" (14,900 tons), the largest vessels engaged in the Canadian trade.

The "Laurentic" (Plate XLII) is a single-funnelled, two-masted steamer, 565 feet in length, with a beam of 67 feet. She carries 260 first-class, 430 second-class and 1000 third-class passengers, in addition to a large quantity of cargo. She is designed on the cellular double-bottom plan, the double-bottom extending the whole length of the ship, and being specially strengthened under the engines to give still greater rigidity in the vicinity of the machinery. The vessel has nine watertight bulkheads, dividing her into ten watertight compartments. The engines of the "Laurentic" are an interesting combination of reciprocating engines with a low-pressure turbine, this being the first steamer designed with such an arrangement of machinery. She is a triple-screw steamer, each of the wing propellers being driven by four crank triple-balanced engines, and the central propeller by a turbine. The object is, of course, to retain the advantages of the highly-perfected balanced reciprocating engines, and at the same time get the benefit of the further expansion of steam in a low-pressure turbine, while avoiding the necessity for an astern turbine, which is essential in a steamer driven by turbines only. In the "Laurentic," both for going astern and manœuvring in and out of port, the reciprocating engines are sufficient, as they develop more than three-fourths of the total combined horse-power.

The White Star Line has services from New York and Boston to Mediterranean ports *viâ* Azores. The vessels engaged in the summer are the "Cretic" (13,518 tons), "Canopic" (12,097 tons), and "Romanic" (11,394 tons), to which in the winter are added the "Cedric" and "Celtic."

Of various freight and live-stock steamers the largest are the "Georgic" (10,077 tons), "Cevic" (8300 tons), and "Bovic" (6583 tons); the first-named, for example, will carry 10,000 tons of cargo.

PLATE XLIII.

ALLAN LINER "VICTORIAN" READY FOR LAUNCHING.

Of several vessels built previously to 1892 with the idea of separating the passenger and cargo services, only the "Naronic" calls for special mention, for in the fate of this vessel was exemplified the perils of ocean voyaging, against which the utmost human ingenuity and forethought are powerless. The "Naronic" when only a year old, sailed from Liverpool on February 11, 1893, and after she left sight of Ireland was never again seen. A few weeks later a vessel picked up a couple of the "Naronic's" empty boats in mid-Atlantic, and for the rest nothing can be known until the sea gives up its dead.

Such a tragedy causes one to doubt the claims of the much vaunted double-bottoms and watertight compartments. In a case of collision, however, it is possible for a vessel to be injured to such an extent that the watertight compartments are useless unless the doors can be closed in an instant, which would give passengers and crew no chance of escaping. In the case of the "Naronic" in all probability she collided with a derelict, a water-logged hulk, of which there are many floating about the oceans to the danger of all shipping.

CHAPTER XIX

THE ATLANTIC FERRY

Part II

IT was in June, 1819, that Alexander Allan sailed in his brig "Jean" of 73 tons register from Glasgow to Quebec, and ever since the famous shipping family has been associated with Britain's premier colony. The Allan Line has steadily advanced with the times and with Canada's constant progress; and almost without intermission has carried the mails since 1856.

The Allan Line steamships are twenty-eight in number, aggregating 160,569 register tons. Of these vessels only seven exceed 8000 tons each; but five of them, the "Victorian," "Virginian" (Plates XLIII, XLIV), "Corsican," "Grampian" and "Hesperian," total about 53,000 tons, and have been built within the last few years. The "Buenos Ayrean," which the Company floated in 1879, was the first Atlantic steel steamer; and the "Victorian," which took the water in 1904, was the first turbine steamship to cross over to the New World. The "Victorian" and "Virginian" are triple-screw

PLATE XLIV.

S.S. "VICTORIAN"—LADIES' BOUDOIR.

steamers each 12,000 tons gross; they are propelled by three turbines, each of which drives one propeller, revolving at a speed of nearly 300 revolutions per minute. Both of these vessels have beaten all records for the passage to and from Canada. The "Virginian" has steamed from Rimouski, the Canadian mail station, to the north of Ireland in 5 days 4 hours; and the "Victorian" has made the passage from Liverpool to Montreal in 6 days 22 hours, or an average speed of 18·4 knots per hour. The time from land to land only occupied 3 days 22 hours. Montreal is an ocean port with the unique advantage of being nearly a thousand miles inland, for it is 986 miles from the city wharves to the Straits of Belle Isle; it is 315 miles nearer to Liverpool than is New York; and one-third of the voyage to Europe is in the comparatively smooth waters of the river St. Lawrence, so that the exposed ocean travel is reduced to about a hundred hours, one-third of which is spent in sleep.

There are four main Allan Line services to Quebec and Montreal, viz. from Glasgow, Liverpool, London and Havre during the St. Lawrence season, from April to October. During the remainder of the year, when the great river is icebound, the terminii are St. John's (Newfoundland) and Halifax. Among other services is a fortnightly one to Boston. In a service to the River Plate the steamers leave

Glasgow and complete their loading at Liverpool outwards; and homewards return to Glasgow after calling at a continental port.

In Chapter XV was mentioned the "Arizona's" perilous encounter with an iceberg, to which danger in winter all Canadian-going vessels are, more or less, naturally subject owing to their northern course. On May 17, 1909, the "Madura" from Newcastle became completely surrounded by an ice-pack to the north-east of Cape Race; and only escaped the next day owing to the shifting of the wind, which opened up a channel behind her and enabled her to get clear. At one time she narrowly escaped destruction between two 90 feet walls of ice; and the captain took measurements of one iceberg, 3300 feet long and 400 feet high.

The "Bisley" arrived at New York on the same day as the "Madura"; during her passage through a similar, or the same, ice-pack she lost three out of her four propeller blades, and some of of her plates below the water-line were badly bent.

The Canadian Pacific Railway Company entered into the shipping business in 1891, and possesses a fleet of 63 steamships registering 193,000 tons. Fifteen of these ships were purchased from Elder, Dempster and Co. in 1903. Their mail steamships, "Empress of Britain" (Plate XLV), and "Empress of Ireland," during their short existence have become great favourites for the Transatlantic passage

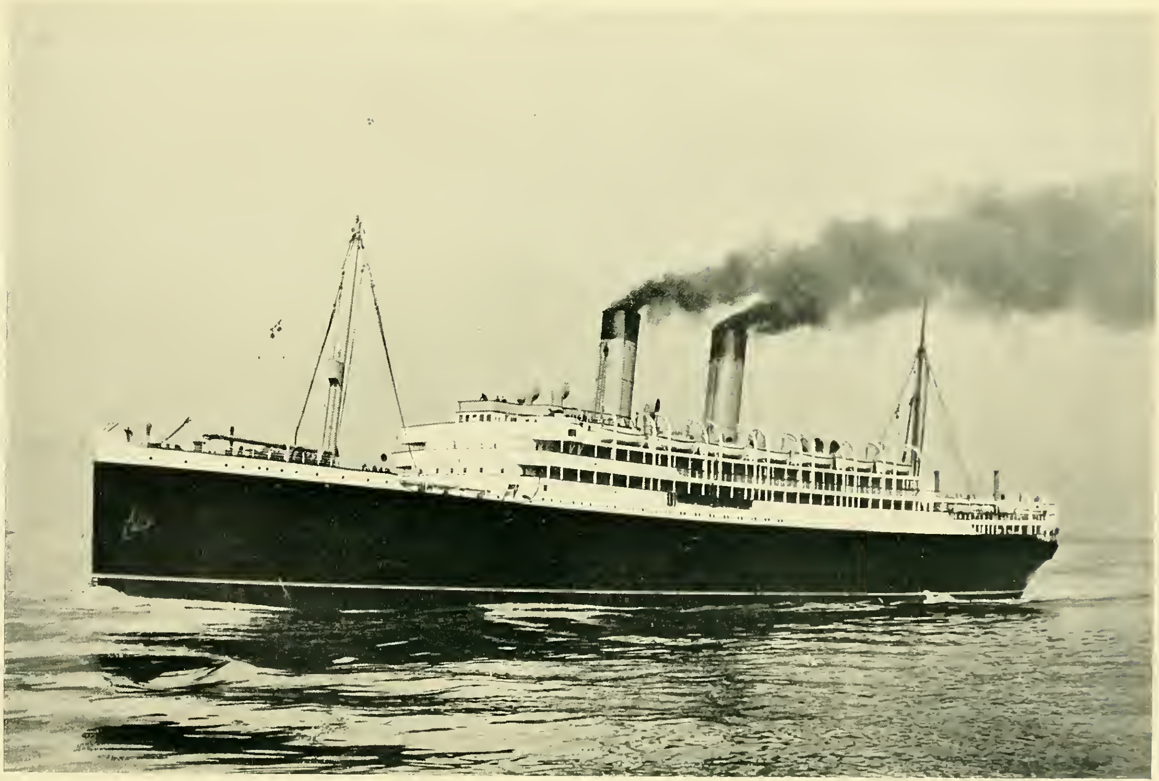


PLATE XLV.

C.P.R. "EMPRESS OF BRITAIN."

They are sister vessels and are of identical dimensions: Length, 570 feet; breadth, 65½ feet; 14,500 tons register; and 18,000 indicated horse-power. They accommodate 350 first cabin, 350 second cabin, and about 1000 third-class passengers. Both boats are capable of 18 knots, and have accomplished some very fine passages, of which may be quoted: "Empress of Ireland," 6 days 1 hour 7 min. from Liverpool to Quebec, and "Empress of Britain," Rimouski to Liverpool, 5 days 6 hours 26 min. On Plate XLVI is shown a wireless telegraphy room on one of the C.P.R. steamships.

The New World is the constant refuge of large numbers of emigrants from the darkest and most poverty-stricken recesses of Europe; in many cases they are flying from countries that have not proved to be their motherlands, but harshest of stepfatherlands. Of this class are thousands of Jews forced out of Russia by oppressive laws. One perhaps wonders why the Canadian Pacific Railway and other shipping lines refuse to carry foreigners third-class, except Scandinavians, upon their best appointed steamships. The answer will be found in the following account of catering for a number of aliens during the passage from Hamburg to Grimsby, en route for Liverpool and Glasgow, there to embark on the liners that specially engage in this class of traffic.

"When dinner-time came there was a general tumbling up from below. With a big basket of thick slices of bread before him, and a stack of enamel plates by his side, a steward seated himself near a huge pan of hot stew, by which stood one of the crew with a ladle. A quick procession marched past. From the steward each man received a plate and a slice, and almost at the same moment the plate was filled from the ladle, and a spoon thrust into the emigrant's hand by a boy.

"Most of the men planked down their plates on the roof of the hold hatchway, and began to 'wolf' their meal. A few seated themselves on the deck, and did their utmost to 'enjoy' their food, but for the most part they seemed bent on devouring the stew and returning in mute appeal for more.

"Soon the deck was strewn with little greasy heaps, and to this was quickly added the offal of herrings and potatoes boiled in their jackets, the 'second course.' The barrels of herrings and the big tin of potatoes were placed on deck so that all could help themselves. Parts of the deck began to present a sickening spectacle, and there was general relief when the hose was turned on and the ship swept clean again."

No such scene could take place in the steerage of even the lowest class British liner, where if the food is plain, it is good, and served decently at

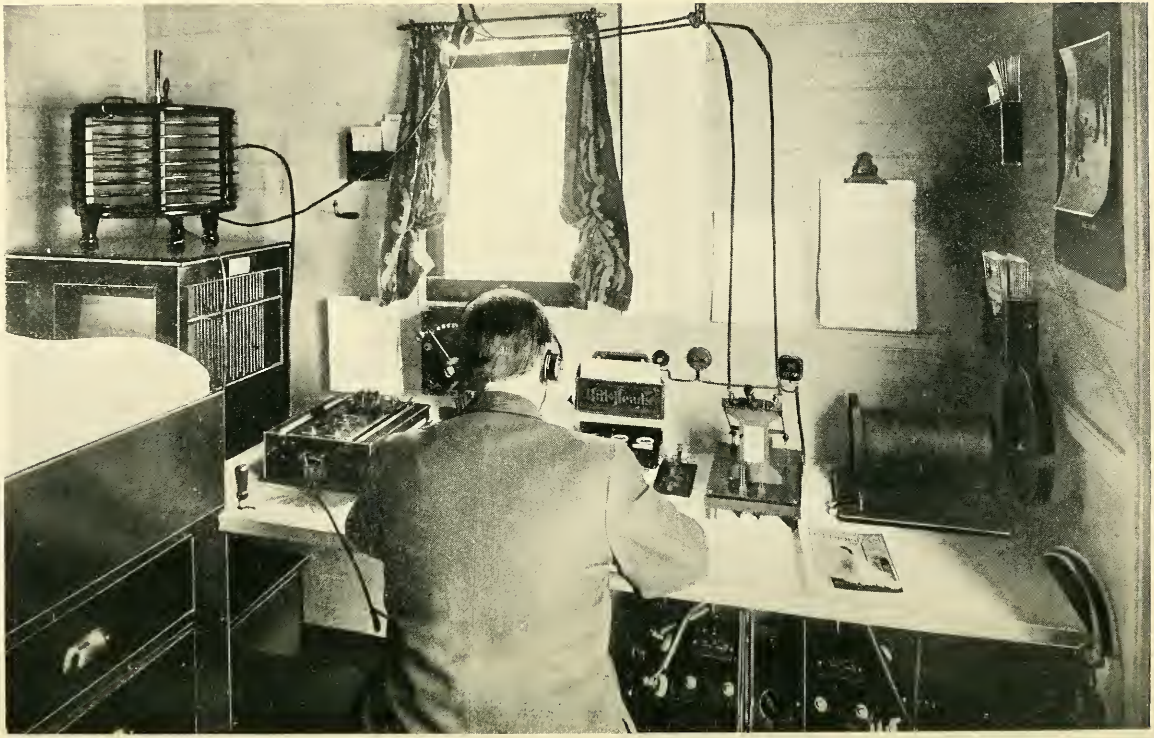


PLATE XLVI.

C.P.R. WIRELESS TELEGRAPHY ROOM.

tables in the steerage saloon. The Canadian Pacific third-class bill of fare is typical of the meals provided for passengers whose passage-money is as low as £5 15*s.* Breakfast: oatmeal porridge and milk, pork or mutton chops, Irish stew, bread and butter, preserves, coffee. Dinner: rice soup, corned beef and vegetables, stewed mutton, vegetables, stewed prunes and rice. Tea: cold meats, pickles, bread and butter, preserves, tea. Supper: gruel, biscuits and cheese.

The officers of British liners, from the captain downwards, are men specially selected for their knowledge of navigation and their judgment and tact in dealing with the passengers entrusted to their care. The organization of a ship with several thousand souls aboard is as intricate as the government of a small town, with the ever-present element of danger to complicate matters. Alien passengers, in particular, are difficult to control when circumstances out of the ordinary arise.

In April, 1910, the liner "Cairnrona," with five hundred alien emigrants on board, caught fire off Beachy Head, while outward-bound for the States. The fire was caused by an explosion of gas which had generated in the coal bunkers. It was shortly after six in the morning when a violent explosion blew off a hatch, injuring some women and children, who were sitting upon it. There was at once a panic among the passengers, mainly

Russians and Armenians, men and women running about the decks wringing their hands in despair. The officers of the ship attempted to pacify them, but without avail; and as the smoke poured out of the hold in dense volumes the panic increased. Although the fire was got under and there was no real danger, the aliens got so out of hand that it was necessary to signal: "Mutiny on board," and a force of Royal Marines went to the aid of the officers. Eventually the whole of the aliens were brought ashore and despatched to London to await another vessel. The old Inman Line is now the American Line, another important organization that forms part of the International Mercantile Marine Company; and its two famous vessels the "City of New York" and "City of Paris" have changed their names to "New York" and "Philadelphia" respectively (Plate XLVII).

It was on the last named that occurred one of those incidents that make us proud of our race. The vessel was making a record run, and in twenty-four hours expected to reach Queenstown. She narrowly escaped making Davy Jones's locker instead. There was a frightful crash; steam belched out of the engine-room; the ship trembled from stem to stern; and through the hissing steam the terrified engine-room staff tumbled up on deck. Down below there was an awful racket. The starboard shaft had broken, and, like a giant flail,

PLATE XLVII.

AMERICAN LINE S.S. "PHILADELPHIA" (formerly "CITY OF PARIS").

the ponderous connecting rod was battering the machinery to pieces, and even shattering the steel bulkheads. Any moment the bottom of the ship might be perforated and endanger hundreds of souls.

No one appeared to know exactly what had happened; but some terrible peril was imminent and the order was issued to man the lifeboats. There was, however, no need to man them. To John Gill, the second engineer, came almost inspired knowledge of what had occurred, and with it the calm assurance of the true hero. He darted down into the steaming inferno at the peril of his life, and brought the whirling machinery to a standstill. Thus did John Gill prove himself to be one of the bravest men in the world's mercantile marine, where heroes are by no means scarce.

For convenience sake we may now dispose of the other lines that form part of the International Mercantile Marine Company. The Atlantic Transport Line has four big passenger twin-screw steamers, sailing from Tilbury Dock, London, to New York, viz. "Minnewaska" (14,220 tons), "Minneapolis," "Minnehaha" and "Minnetonka," each over 13,000 tons; the "Mesaba" is only half the tonnage. A feature of this line is that it only caters for first-class passengers. The "Minnewaska" is 600 feet long, with a beam of 65 feet, or the same sized vessel that is generally capable of carrying 2000 first, second and third-class passengers; but as she only provides for 326 first-class passengers, they enjoy far more space than is usually the case in an ocean passage.

The Dominion Line has changed its name to the British and North Atlantic Steam Navigation Company, and three vessels form the Mississippi and Dominion Steamship Company. Of fourteen steamships only two exceed 9000 tons, and all of them are engaged in passenger and cargo traffic.

On April 19, 1910, the "Englishman" (5257 tons) brought into Queenstown harbour the Wilson and Furness Leyland steamship "Anglian" (5532 tons), which she had towed for 800 miles across the Atlantic. During the whole of the nine days of the tow the hawser never parted. The strain on the "Englishman," however, was so great upon one occasion that the bitts were torn from the vessel. It was six hours before the ships could be reunited. In the meantime temporary repairs were effected to the "Anglian's" broken tailshaft, and the vessel was able to make some way under its own steam, and so lessen the "Englishman's" burden. On the "Englishman" were 470 cattle; and owing to the prolonged voyage they ate up all the fodder three days before Queenstown was reached. Happily "Quaker" oats formed a big part of the cargo, and on these

PLATE XLVIII.

HAMBURG-AMERICAN S.S. "KAISERIN AUGUSTE VICTORIA."

the beasts were fed, greatly to their satisfaction. When the vessel reached port the cattle went back regretfully to hay.

The Red Star Line has regular services from Antwerp to New York, Boston, Philadelphia, and Baltimore, calling at Dover. Of ten vessels, the smallest of which is 6848 tons burden, the "Lapland" is not the largest, but claims to be in the front rank of ships crossing the Atlantic. She was constructed by Messrs. Harland and Wolff, and is by far the largest vessel sailing under the Belgian flag. She is over 620 feet long, 70 feet beam, 50 feet deep and 18,694 tons gross register, and is designed to carry a large quantity of cargo and over 2500 passengers.

Another of the allied companies is the Leyland Line of Liverpool, with 42 steamers with an aggregate tonnage of 240,000. They carry a fairly large cargo and only first-class passengers. Its chief service is Liverpool to Boston.

No account of the Atlantic Ferry would be complete without reference to the two great German shipping lines, not only on account of the enormous aggregate tonnage of their vessels, but for the impetus which their competition has undoubtedly given to British shipping.

The Hamburg-American Line was established in 1847, and from very insignificant beginnings has grown to such magnitude, that to-day the

Company's fleet comprises 387 vessels with a tonnage of nearly a million; of these 164 are ocean steamers, 35 of which are large, new, twin-screw passenger vessels. Notwithstanding the large number of ships owned, the average age of each is less than nine years. The Company's operations include no less than sixty-eight different services, reaching nearly every important port of the globe. In the Hamburg-New York service five large vessels are engaged, viz. "Deutschland," "Kaiserin Auguste Victoria," "Amerika," "Cleveland," and "Cincinnati," calling at Southampton and Cherbourg outwards, and Southampton and Boulogne homewards.

The name "Deutschland" (Plate XXXIV) is an historic one in the annals of the Company; their first ship to cross the Atlantic was of that name; she was a square-rigged three-master of about 717 tons. Comparing the "Deutschland" of 1847 with that of to-day is to gain a good idea of the marvellous progress of marine construction. The dimensions of the vessel have been given on page 232. She made shipping history when, by means of her 16 boilers, fed by 112 fires and developing 37,000 horse-power, and her 23 feet diameter screws, she gained for Germany the blue ribbon of the Atlantic.

The "Amerika" and the "Kaiserin Auguste Victoria" (Plate XLVIII) are of ponderous size and

PLATE XLIX.

WINTER GARDEN, "KAISERIN AUGUSTE VICTORIA.'

stately lines. The former is 687 feet by 75 feet by 53 feet; registered tonnage, 22,622; displacement at full load draught, 42,000 tons; the latter is 700 feet by 77 feet by 54 feet; registered tonnage, 25,000; and displacement about 43,000 tons.

The "Amerika" has accommodation for 420 first-class passengers, 300 second-class, 300 intermediate, and 2300 steerage passengers.

The "Kaiserin Auguste Victoria" is one of the most splendidly appointed vessels afloat. The Winter Garden (Plate XLIX) is only one of its many magnificent apartments. The gymnasium is particularly well equipped with all kinds of gymnastic apparatus. On Plate L is shown the gymnasium aboard the "Amerika." When a rider is astride the saddle in the foreground and a machine is put in motion, he gets exactly the same exercise as though he were mounted on a real steed. In the background is a camel saddle; so that passengers proceeding from the New World to the East can obtain some preliminary practice in that strenuous, back-breaking exercise, camel-riding.

On Sunday, March 28, 1909, the "Kaiserin Auguste Victoria" arrived at Plymouth. She had steamed 2000 miles, without her officers being able to take any observation, the weather being so thick and foggy that the sun had not once been seen. After leaving New York on Tuesday the first thing sighted was the Eddystone Lighthouse.

The "Cincinnati" and "Cleveland" have each a tonnage of 18,500, and are remarkably fine vessels, their second-class accommodation, in particular, being claimed to surpass anything ever provided before. There are other American services employing large and well-appointed vessels, such as the "President Grant" and "President Lincoln," each exceeding 18,000 tons, with accommodation for 324 first-class passengers, 125 second-class, 1000 third-class, and 2400 fourth-class. If these two great ships are eager competitors with British lines, it is some slight satisfaction to learn that they were built by Messrs. Harland and Wolff. Another notable vessel is the "Hamburg," one of three well-known boats engaged in the New York and Mediterranean service. This steamship registers about 11,000 tons, and is distinguished for having been more than once chartered by the German Emperor as his private yacht during his cruises to the Mediterranean. Colonel Theodore Roosevelt, ex-President of the United States, also used the "Hamburg" on the trip to Italy, en route to East Africa on his notable hunting expedition.

The Hamburg-American Line has under construction a new vessel, the "Europa," 900 feet in length and of 46,000 tons. This ship will be bigger than the White Star leviathans, but will be less than the projected new Cunarder, the

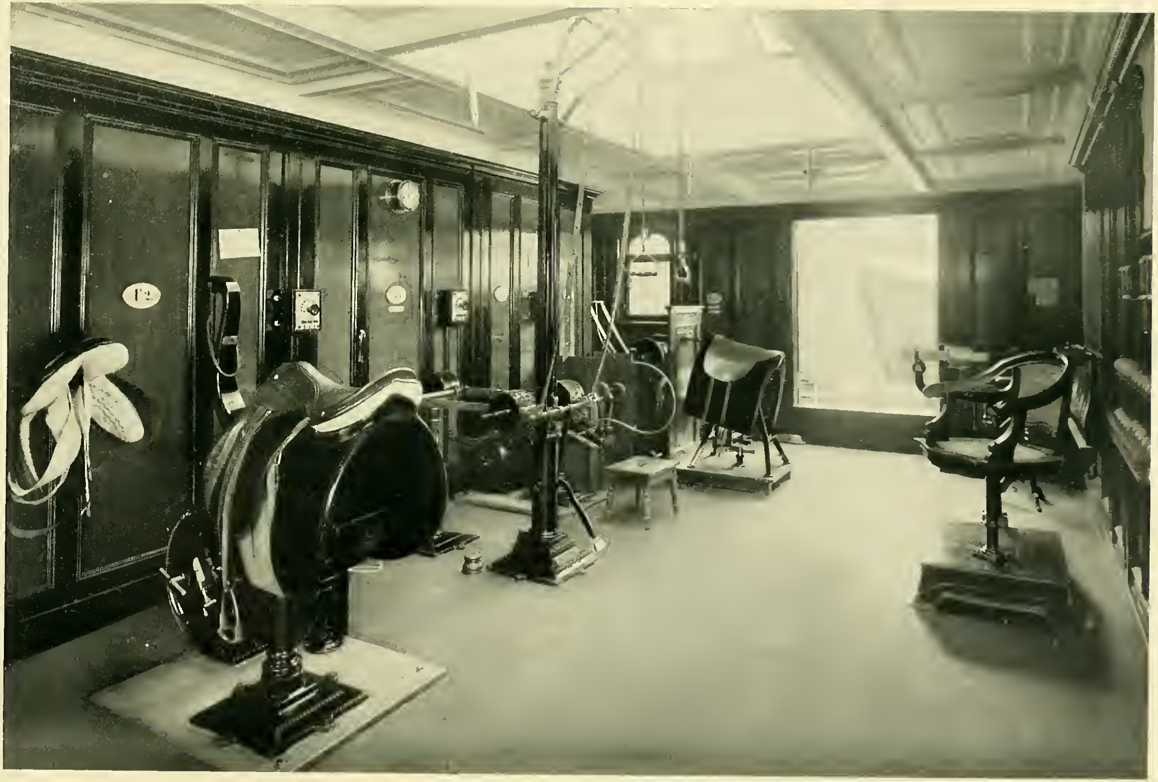


PLATE L.

GYMNASIUM, S.S. "AMERIKA."

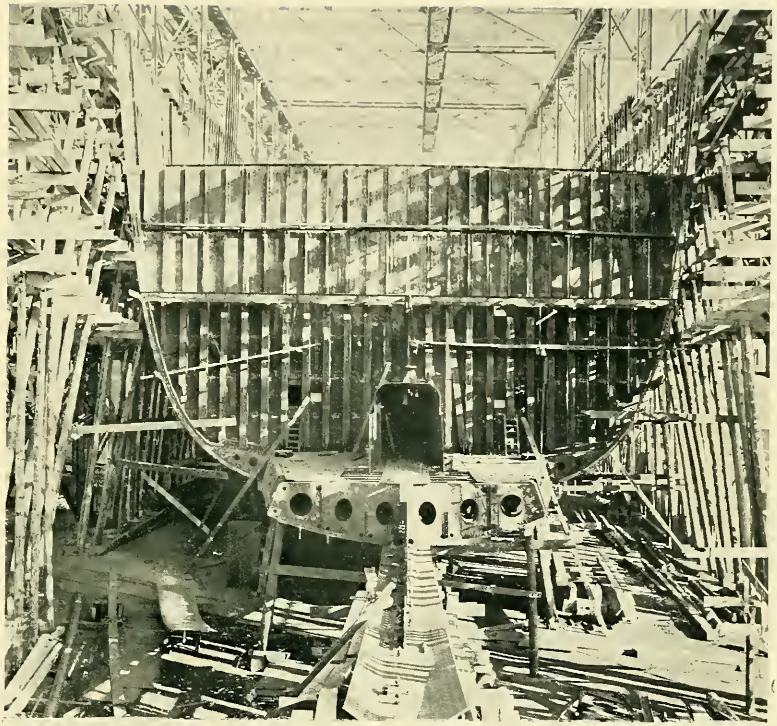
"Aquitania." This ocean giant is to be of 50,000 tons and 23 knots, and will probably cost two millions sterling. It will be propelled by turbines, and probably will be fitted to carry oil fuel.

The Norddeutscher Lloyd Line commenced operations in 1856 with services to Hull and London. Its first Atlantic effort was made two years later, when the "Bremen," 334 feet by 42 feet by 28 feet, sailed to New York *viâ* Southampton with 114 passengers and 150 tons of cargo. Its fleet now consists of 195 ocean steamers, aggregating 752,037 tons. Its ships travel over six million miles in a year, carrying nearly three-quarters of a million passengers, and nearly four and a half million tons of cargo.

The "Kaiser Wilhelm der Grosse" and "Kaiser Wilhelm II." have already been referred to in connection with quick passages across the Atlantic; and though they have been eclipsed in size they are still popular vessels. In the last week of August, 1909, the former crossed from New York to Plymouth with 1222 bags of mails for London; the time between the vessel's arrival within the breakwater and the mails reaching Paddington was only 5 hours 19 min., the railway run occupying exactly 4 hours without a stop. In the course of this passage the great liner had an unusual experience. During misty weather on the banks of Newfoundland she came into collision with a large whale, which was impaled on the bow, and in this position was driven a considerable distance before the vessel. At length the "Kaiser Wilhelm der Grosse" had to go full steam astern to free herself from the encumbrance.

Three imposing recent additions to the N.D.L. fleet are the "Kronprinz Wilhelm," 14,908 tons, "Kronprinzessin Cecilie," 19,403 tons, and the "George Washington," 27,000 tons; and a description of the last named must serve to illustrate the energy and enterprise of the Company.

In size the "George Washington" surpasses the other famous vessels of the fleet, being about one-fourth again as large as the "Kaiser Wilhelm II." Some idea of the colossal proportions of the new ocean giant may be gathered from the following dimensions of the vessel. Length, 722 feet; beam, 78 feet; depth, 80 feet from awning deck. Speed, 18·5 knots. Her displacement at 33 feet draught is 37,000 tons; registered tons, 27,000; horse-power, 20,000; cargo capacity, 13,000 tons; accommodation for 2940 passengers. The best German vessels have always been noted for the magnificence of their interior decoration and furnishing, and in these respects the "George Washington" is second to no vessel afloat. All the rooms are lighted by electricity, entailing 4100 lamps. Great attention is always paid to the ventilation of ocean liners, which in this case is secured by 24



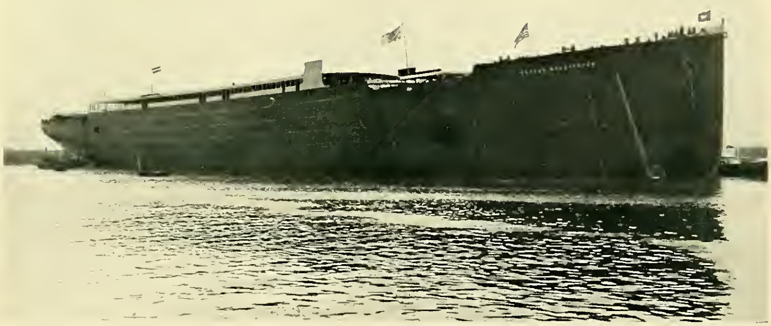


PLATE LI.

NORDDEUTSCHER LLOYD S.S. "GEORGE WASHINGTON" BUILDING.

LAUNCHED.

electrically operated centrifugal ventilators, capable of supplying 105,000 cubic feet of fresh air a minute. Twelve watertight transverse bulkheads, all reaching to the upper saloon deck, divide the ship into thirteen watertight compartments, the thirty-six doors of which may be closed and the ship practically hermetically sealed within fifteen seconds. Among the working force of 525 men are ten barbers and hairdressers. It seems almost impossible to mention anything that has been omitted that would conduce to the comfort of the passengers, down to the twenty specially constructed dog kennels, in charge of a competent kennel master, where the pets of passengers may be placed during the trip and receive the best of care. The illustrations (Plate LI) show the "George Washington" in course of construction and as she appeared when launched.

It is impossible within the space at our disposal to attempt to describe more than a fraction of the steamships engaged in the North Atlantic trade; but sufficient has been said to show its enormous proportions and the vast improvements which the shipbuilder has effected in marine locomotion. Our consideration has mainly been devoted to passenger steamers, most of which in addition carry immense amounts of cargo. A cargo steamer, pure and simple, in its registered tonnage is often a very dwarf compared to the big liners that have been under consideration, but it is astonishing what an enormous freight can be stuffed into the gaping holds.

The "Manchester City" is only 7696 registered tons, yet it has brought across the Atlantic to the docks of the Manchester Ship Canal an assorted cargo such as the following: 450 cattle, 150 sheep, and a couple of horses; 469 cases of poultry, 1400 boxes of butter, 12,000 boxes of cheese, 37,000 bushels of oats and 1500 bags ditto, 67,000 bushels of maize, 39,900 bushels of wheat, 3400 bales of hay, 6470 bundles of pulp, 1000 sacks of oatmeal, 1080 cases of eggs, 1250 tierces of lard, 3600 bags of starch, 500 bags of sugar, 246 standards of deal, 4274 doors, 245 bundles of doors and numerous packages of dry goods. The weight of the cargo, 7500 tons, is not nearly so remarkable as its bulky and miscellaneous nature.

CHAPTER XX

TO THE FAR EAST AND AUSTRALASIA

ALL ocean-going vessels outside the North Atlantic services are small in comparison with the great liners that have hitherto been described; but in all the well-known lines the vessels are replete with every provision for the comfort and safety of the passenger. In dealing with some of the worldwide routes we may very well consider the shipping more in its historical, geographical and economic aspects.

From the British Isles, like the spokes of a wheel, diverge a great number of routes of which it will be possible to mention only those of outstanding importance, confining ourselves to a few of the better known lines that serve them.

The Peninsular and Oriental Steam Navigation Company commenced its career in 1837 by a service of mail packets from London to Gibraltar, and in the course of a few years the Line was extended to Malta and Alexandria. The first P. & O. steamer despatched to India was the "Hindustan"

(1800 tons), which left England in September, 1842, her departure being regarded as quite a national event. Two years later the company undertook a mail service extending from England to Alexandria, and from Suez to Ceylon, Madras and Calcutta, with a further extension in due course to China.

The Suez Canal was not then in existence, and many years elapsed before the construction of a railway from Alexandria to Suez. The Overland Route across Egypt was partly by means of the Mahmoudieh Canal and the Nile and partly by land, a hundred miles of which was absolute desert. To convey a single steamer's loading called for the employment of 3000 camels, and every package was submitted to three different transfers between the Mediterranean and the Red Sea. Steam communication with Australia was inaugurated in 1852 by a branch line from Singapore; and two years later the Company secured the service between Suez and Bombay, which had hitherto been in the hands of the East India Company.

The opening of the Suez Canal in 1869 was of vital importance to our trade with the East, affording an all-water route 4000 miles shorter than *viâ* the Cape. The Canal consists of 66 miles of constructed channel and 21 miles of lakes; it cost £20,000,000. In 1875 the British Government purchased the Khedive of Egypt's share; and it was to preserve our interests that we occupied the Land of the Pharaohs in 1882, and have since remained there helping the Egyptians to restore prosperity to their ancient kingdom.

The Suez Canal brought about a signal change in the operations of the P. & O., entailing almost entire reconstruction of a large and complicated business, which opens up questions too intricate for present discussion, except so far as the conveyance of mails is concerned. Up to this time the cost of steam navigation in the Eastern seas was enormous, for coal alone was 60 to 80 shillings a ton, and thus the transport of the mails called for a large Government subsidy. In the Eastern trade the passenger business is small and the season short compared to such a route as across the North Atlantic; and but for the mails, vessels of 18 knots would not be employed. A mail vessel, when loaded and coaled has a displacement of about 15,000 tons, carrying only 3500 tons of cargo; whereas a cargo steamer of 12 knots, and with a similar displacement, will have a cargo of 9000 tons.

The P. & O. commenced their service with two or three very small steamers, of which one, the "William Fawcett," was only 209 tons; but to-day the Company's fleet of 61 vessels approximates to 460,000 tons. They are all modern ships, not one having been floated earlier than 1890. Vessels are not discarded because of decay in their material, but the progress of the shipbuilder and the engineer calls for vessels of the most advanced type, if shipowners are to hold their own successfully. It may be mentioned that many vessels discarded by the British mercantile marine are bought up by foreign owners for another spell of service under a different flag.

The P. & O. claim to be the first company to adopt the screw in lieu of the paddle on a large scale. Their first screw vessel was built in 1851, and thereafter no more paddle steamers were floated except a few required for special purposes. Several of the Company's larger vessels are under engagement as Admiralty transports, and their boats have often been called upon for transport work from the days of the Crimea onwards. Every year the P. & O. fleet's mileage totals up to about 3,000,000 miles; its coal consumption is about 700,000 tons; and it pays in dues to the Suez Canal a sum far exceeding £300,000.

The best idea of the P. & O. operations is gained by a brief glance at their route map. From England we go through the Mediterranean *viâ* Gibraltar and Malta to Port Said, with side lines from Marseilles and Brindisi, and then through the Red Sea to Aden, from whence there are straight runs to Bombay or to Colombo. From the last named there are three routes, viz. a short one to Calcutta, a second through the straits to Singapore, Hong-Kong, and Shanghai in China, and on to

PLATE LII.

P. & O. S.S. "MOREA."

Yokohama in Japan, and a third from Colombo to Perth in Western Australia, and thence to Adelaide, Melbourne, and Sydney. Calcutta is 8438 miles from England, Yokohama 11,956 miles, and Sydney 12,500 miles.

The eight largest P. & O. vessels are—

Name.	Length.	Beam.	Depth.	Tonnage.
"Maloja"	550	63	39	12,500
"Medina"	550	63	39	12,500
"Mantua"	540	61	25	10,883
"Malwa"	540	61	25	10,883
"Morea"	540	61	25	10,890
"Marmora"	530	60	26	10,509
"Macedonia"	530	60	26	10,512
"Moldavia"	520	58	25	9,500

The "Mantua," sister to the "Malwa" and "Morea," is a twin screw, and forms one of ten similar steamers known as the "M" class. Her passenger accommodation is entirely situated on or above the main deck, so that ports rarely require to be closed on account of weather. The promenade and shelter decks are of wide area, and afford plenty of space for deck games, dances, and other recreations. This vessel is, for a portion of the year, employed in pleasure cruises to Madeira and the Azores, the Norwegian fjords and the northern capitals. The "Mantua" has an electric laundry of the latest type, capable of dealing *en voyage* with passengers' needs in the matter of fresh linen. There are other cruises from London to the Holy Land and all interesting points between, by means of which large numbers of tourists enjoy very attractive holidays for about a guinea a day. The "Morea" is shown on Plate LII.

Of other British companies navigating the Eastern seas may be mentioned the Canadian Pacific Railway, which has vessels sailing from Vancouver to Japan, Western Australia and New Zealand; the Australian route is *viâ* Honolulu, in the Hawaian Islands, and Suva in Fiji, from which last-named there are lines to Brisbane for Sydney, or to Auckland in New Zealand. For the Japan and China service, the "Empress of India," "Empress of Japan," and "Empress of China" are employed. They are twin screw steamers of 6000 tons each, and for safety and comfort are claimed to be the finest vessels traversing the North Pacific ocean.

The British India Steam Navigation Company was incorporated in 1856, though not under its present title, to carry on mail services for the East India Company. The services cover a wide area, and include mail contracts to and from Arabia, Persia, India, Burmah, East Indies, Mauritius, etc., and there are services to Queensland and other places, and a three-weekly line from Calcutta to Manila. The Company's fleet consists of 111 steamers, totalling 452,820 tons. The vessels engage in about 20 services, providing commercial facilities for quite a hundred ports. The largest steamship is the "Queda" (7703 tons), and the latest is the "Rewa" (7267 tons), triple screw, driven by three steam turbines.

The great German lines compete with the British almost everywhere in the East, with services from many important European ports to Egypt, Aden, Colombo, the Straits, China and Japan, and Australasia; and it need only be said that all the vessels they employ rank high in size, speed, and comfort.

The Aberdeen Line trades between London and Australia, *viâ* the Cape. When the notes were made for this paragraph the Company possessed half a dozen vessels, with a total tonnage of 37,450, including the 15-knot steamers "Miltiades," "Moravian," and "Marathon." The latest addition was the "Pericles," the largest British-owned ship carrying first and third class passengers to Australian ports.

The "Pericles" (500 feet by 62 feet by 31 feet; 10,925 tons) was homeward bound with 300 passengers and a miscellaneous cargo, of which the chief items were, 33,000 cases of apples, 10,000 bales of wool, 32,000 boxes of butter, 24,000 carcases of mutton, 710 tons of tallow, 252 tons of copra and 300 tons of lead. She was commanded by Captain Alexander Simpson, who has spent nearly half a century in the English and Australian services, having in the course of his long career made quite eighty round voyages. Captain Simpson is a keen student of ocean currents, and every day at noon for many years he has thrown overboard a sealed bottle, in which is a printed slip, giving in five languages the date, position of the vessel, and asking the finder to return the bottle to him. Over a thousand of these missives have been picked up and duly returned, and the information thus gleaned has been of conspicuous service to navigators generally.

On March 31, 1910, when the "Pericles" was a few miles to the south of Cape Leeuwin, everything on board was as usual; some passengers were engaged in playing deck golf. There was a sudden shock, and from down below came a roar as if steam was escaping below the water-line. The vessel heeled to starboard but kept moving, then heeled to port, still moving. The whistle blew and the order was issued to man the boats. There was no panic; they were swung out in commendable order; the passengers took their seats; and the boats left the ship's side for the shore. Before the beach was reached the sailors, cooks, stokers and stewards plunged into the waves to haul up the boats and carry the passengers ashore dryshod. Many of the people were only partially clothed, but assistance was speedily forthcoming from the districts nearest the scene of the wreck, and as quickly as possible the "Monaro" arrived to convey the castaways to Fremantle. The "Pericles," which had struck an uncharted rock, sank head down shortly after she was abandoned; and the fact that 462 lives were saved in 28 minutes is splendid testimony to the bravery of the British sailor and the coolness of British passengers in the face of grave peril.

The Blue Anchor Line in 1909 lost a vessel under much more tragical circumstances. The "Waratah" (9339 tons), bound from Sydney to London, duly reached Port Natal with 300 passengers aboard. She left that port en route for Capetown, which she should have reached on August 1. When she was overdue several days the "Solveig" arrived, reporting rough weather in Algoa Bay, which had swept her deck gear away. It was supposed that the "Waratah" was disabled, and a tug and a couple of warships went out to meet her. A week elapsed, and in the churches at various Australian ports there were hymns and special prayers for the safety of the vessel and her passengers. At first it was thought that possibly she had broken her steering gear and contrary currents had carried her far out of the course. No wreckage was found, and the vessel being provisioned for two months, in addition to her cargo of hundreds of tons of flour and thousands of frozen carcases of mutton, it was hoped all would yet prove well. Weeks grew into months, and at length the "Waratah" was accounted lost for ever, another of those mysteries with which the shipping world is sadly familiar.

The New Zealand Shipping Company, though organized at Christchurch, New Zealand, as late as 1873, for the first ten years carried on business with sailing ships, specially built for passengers and the colonial trade. The fleet now musters 17 steamers, aggregating 118,410 tons. Of eleven twin screw steamers the largest are the "Turakina" (8349 tons) and the "Ruapehu" (7885 tons). This Company's "Mataura" sailed from Chalmers in 1882 with 150 tons of frozen mutton, prepared on board in the absence of the necessary plant ashore.

Australian and New Zealand steamships are now largely engaged in the frozen mutton trade, and in a single year they transport meat to the mother country to the value of about £4,000,000, in addition to vast quantities of dairy produce.

At one time sheep were reared in Australia and New Zealand for the sake of their wool alone, until refrigerating machinery was invented, by means of which meat could be kept for months in a perfectly sound condition. After a sheep has been slaughtered, skinned and dressed, the carcase is hung up for some hours to cool, when it is transferred to the freezing chamber. The cold atmosphere is produced by steam power in which

PLATE LIII. NEW ZEALAND MUTTON PASSING FROM RAILWAY REFRIGERATING VAN INTO VESSEL'S HOLD.

air at its ordinary temperature is compressed to about one-third of its natural bulk, and then introduced into a chamber with walls that are impervious to heat. The sudden expansion of the air to its natural bulk reduces it to about one-third of its former temperature, and this state of intense cold is maintained by steam power.

When the carcases are frozen, they are enclosed in clean calico bags and are placed in similar refrigerating chambers in the holds of the steamships (Plate LIII) that convey the meat 12,000 or more miles across the world. Upon arrival at our ports the mutton is transferred to freezing chambers ashore, from which it is taken as required for distribution to different parts of the country.

To show the freight capacity of a steamer built for the New Zealand trade may be quoted the case of the "Orari." She is but a vessel of 7200 tons, yet a recent cargo consisted of 20,000 bales of wool, 18,000 carcases of mutton, 41,700 carcases of lamb, in addition to much general cargo.

The Orient Line to Australia has ten steamers with a tonnage of nearly 100,000. The "Orvieto" and "Otranto" are each 12,124 tons; the "Osterley," "Orsova," and "Otway," are 13,000 tons each; and they are among the finest and largest vessels running east of Suez. They visit eleven ports between London and Brisbane; and notwithstanding the many calls, they make Sydney in 41 days, or in 31 if the railway is made full use of.

The Shaw, Savill and Albion Co. has twelve vessels totalling 89,000 tons. Passenger steamers leave London, calling at Plymouth, Teneriffe, Capetown and Hobart; and on the homeward journey *viâ* Cape Horn, call at Monte Video, Rio de Janeiro, Teneriffe and Plymouth; there is also a service from Glasgow and Liverpool to New Zealand. Among the best of their boats are the "Arawa" (9372 tons) and "Tainui" (9957 tons). This line is largely interested in the refrigerated meat business, and annually carries about 3,000,000 carcases.

The White Star Line is also interested in the Australian and New Zealand trade; and as may be expected, its vessels are the largest sailing from the United Kingdom to these waters. The "Athenic" (12,234 tons), "Corinthic" (12,231 tons), "Ionic" (12,232 tons), and the "Delphic" (8233 tons), trade with New Zealand; and the "Afric" (11,948 tons), "Medic" (11,984 tons), "Persic" (11,974 tons), and "Runic" (12,482 tons) run to the Australian ports.

PLATE LIV.

R.M.S.P. S.S. "ASTURIAS."

CHAPTER XXI

ROUTES HERE AND THERE

WHEN the Royal Mail Steam Packet Company started its career under a Royal Charter in September, 1839, the scope of its operations was clearly marked out, viz. "for the transmission of the mails to and from Great Britain, the West Indies, North and South America, and such other foreign ports as the public service may require." Other charters were granted in 1851, 1882 and 1904. The two former extended the Company's operations, but the chief feature of the last was a clause that insisted upon the Company remaining entirely under British control, no foreigner being qualified to act as a director, or to be employed as one of the principal officers of the Company. This drastic condition was aimed against the Company ever becoming party to a combine, such as had robbed Britain of full control over some of the best of our North Atlantic shipping.

The R.M.S.P. Company commenced business with a fleet of 14 steamships, all capable of carrying guns of the largest weight and calibre then used on H.M. men-of-war; and a naval officer was aboard each ship to superintend the mails, as well as to supervise the vessel generally. The first vessel, the R.M.S.P. "Thames," opened the mail service to the West Indies in 1842, and though she started from Falmouth, she returned to Southampton, which port has ever since been the headquarters of the Company. At the end of fifteen years the agreement with the Government was renewed conditionally upon the doubling of the service to Colon, and the establishment of a monthly line to Brazil and the River Plate.

To secure quicker transit to the West Coast of America the Company organized mule and canoe transport across the Isthmus of Panama; and when a railway was built in 1855, the Company assisted to finance it. The railway is not one of the best managed in the world. The Panama Ship Canal now in course of construction will revolutionize some of the world's great shipping routes. From Plymouth to Callao *viâ* Straits of Magellan is 10,000 miles, and to San Francisco, 13,549 miles; but the new channel will reduce these to 5900 and 7800 miles respectively. The British lines to Australia and the Far East will remain unaffected, but for vessels from New York there will be a saving of 3000 miles to Melbourne and 5000 miles to Yokohama.

PLATE LV.

CHILDREN'S SALOON, S.S. "ARAGUAYA."

BEDROOM-DE-LUXE, S.S. "ARAGUAYA."

The R.M.S.P. Company now owns nearly 50 vessels with a total tonnage of 195,000. The chief New World services are :—

1. To West Indies and New York: From Southampton, calling at Cherbourg, and thence proceeding to Barbados, arriving there on the thirteenth day out; and then after calling at Trinidad, La Guaira, Colombia, Cartagena, Colon, Jamaica and Antilla, proceeding to New York, which is reached about 28 days from Southampton.

2. The Islands Service: Leaving Southampton and Cherbourg and thence to Barbados as before, then calling at eight different West Indian islands, outwards and inwards back to Barbados and returning to Southampton. The round trip occupies about 33 days.

3. The British Guiana service: Southampton and Cherbourg to Barbados, transferring there to the intercolonial mail steamer for Georgetown.

4. Brazil and River Plate route: Southampton and Cherbourg to Coruña, Vigo, Lisbon, Madeira, St. Vincent, Pernambuco, Bahia, Rio de Janeiro, Monte Video and Buenos Ayres.

The four largest R.M.S.P. steamships are the "Asturias" (12,002 tons) (Plate LIV), "Avon" (11,073 tons), "Araguaya" (Plate LV), and "Amazon" (10,037 tons), all twin-screws with a speed of 15 knots. A very well-known steamship is the "Tagus" (5545 tons), which was floated in 1900 and was immediately engaged as a transport during the South African War. She conveyed several shiploads of troops to Capetown; and on June 13, 1901, she left Capetown with the colonial troops, who were returning home to Australia and New Zealand. Since then she has rendered good service on the West Indies and New York route, in which she made a record run from Jamaica to New York in 3 days 21 hours.

The North Atlantic passage is too brief for the voyage to become unduly tedious, but upon some of the longer world-wide routes all sorts of diversions are indulged in to wile away the time. On Plate LVI is shown a variety of deck sports on board R.M.S.P. vessels, but on all ocean-going ships the passengers seek similar distractions.

The Anchor Line with 20 steamers aggregating 114,000 tons, although it has a service to Bombay and Calcutta, is chiefly interested in services from Glasgow to New York *viâ* Moville, and to Portuguese and Spanish ports in South America. Its largest vessel is the "Caledonia" (9222 tons).

The Pacific Steam Navigation Company has 44 steamships with a tonnage of 182,000. Their chief service is from Liverpool to Callao *viâ* France, Spain, Portugal, Brazil and River Plate. The largest steamers are the "Orcoma" (11,532 tons) and "Oriana" (8086 tons).

PLATE LVI.

SPORTS ON DECK.

The Booth Line possesses about 40 steamships, with a total of nearly 140,000 registered tons, many of which sail from Liverpool, Havre, Vigo, Lisbon and New York, to South America, particularly the ports in the Amazon region. Their largest vessels are the "Antony" (6439 tons) and "Lanfranc" (6275 tons). This line is largely interested in the Iquitos Steamship Company, which owns half a dozen steamships that ascend the Amazon as far as Iquitos, 2000 miles from the coast. The largest of these river steamers is the "Ucayali" (3500 tons).

To describe even briefly the shipping interests of Elder, Dempster and Company would require a chapter to itself, for this well-known Company really consists of half a dozen distinct lines. If we look in a shipping directory we discover that Messrs. Elder, Dempster and Co. own a dozen steamships, and the Elder, Dempster Shipping Co. twice as many; but the same firm own the African Steam Navigation Company with 22 vessels, the British and African Steam Navigation Company with 36, and the Imperial Direct West India Mail Company with six capital vessels; and even then the interests of the Company are not exhausted.

The late Sir Alfred Jones, from an office boy in the service of the African Steamship Company, rose to be one of the greatest figures ever known in the shipping world, commanding combined fleets of about 120 vessels with an aggregate tonnage of quite 600,000 tons. The advancement of West Africa, and the West Indies in particular, owe much to the efforts of this great captain of industry. In West Africa he not only made the British name respected for fair dealing all along the broiling coast, but he devoted much thought and money to improving the conditions of life in a region that was long considered to be a grave for white men. He founded a school of tropical medicine to investigate the causes and to provide remedies for the diseases that attack white men in malarious regions.

The trade of some of the West Indian islands had declined into a ruinous condition, largely owing to the competition of beet sugar with the product of the sugar cane; but Sir Alfred brought prosperity back again by encouraging the cultivation of fruit such as the banana and orange, and providing vessels specially constructed with insulated decks, divided into bins, for the conveyance of fruit at cheap rates to the United Kingdom. The Government contract for the direct mail service with the West Indies stipulated that each mail steamer should carry 20,000 bunches of bananas on the return passage.

Another Imperial matter that interested the great shipowner was the growth of cotton in

West Africa, in order to render the Lancashire mills less dependent upon the United States, where the speculators often sadly harass the spinners by artificially inflating the price of the raw material. A most remarkable feature of Sir Alfred Jones was that, whether his ships were at sea or in port, from day to day he knew their exact position, and every captain, officer and purser he was able to greet by name.

The vessels belonging to the allied companies are mostly cargo boats registering only from two to four thousand tons burden. The largest of all is the "Port Kingston" of the Imperial Direct West India Mail Service. It is a twin-screw vessel, 460 feet long by 56 feet wide by 24 feet deep, and 7585 registered tons. She accommodates 176 first-class passengers and 44 second-class, but has a large hold capacity to deal with the West Indian colonial trade. The "Monarch," 470 feet by 56 feet by 31 feet and 7355 tons, is in the service of the Elder Dempster Shipping Company.

The ocean route to South and East Africa is inseparably bound up with the fortunes of the Union-Castle Line, which for many years was controlled by the late Sir Donald Currie, an outstanding name in any list of the World's great shipping magnates. We need not concern ourselves with the amalgamation of the Union and Castle

Lines, but at once proceed to consider the Company's present-day fleet and services.

The Union-Castle steamships number forty-three, with a tonnage in round numbers of 300,000 tons. The main mail service is to Capetown, Algoa Bay, East London and Natal, *viâ* Madeira, for which places vessels leave Southampton every Saturday. In an intermediate service vessels leave London and, after calling at Southampton, proceed to Cape Colony, Natal and Delagoa Bay; alternate vessels go *viâ* Las Palmas (Grand Canary) and Teneriffe and call once a month at Ascension, St. Helena, Beira and Mauritius. During the war with South Africa the Union-Castle vessels rendered great service in conveying men and stores to the seat of war; and the pacification and complete union of the South African States must lead to no inconsiderable increase in the business of one of our most famous companies.

Two well-known vessels are the "Armadale Castle" and the "Kenilworth Castle," sister ships of the same dimensions, and practically similar in all other respects; 570 feet long and 65 feet beam; registered tonnage, 12,975. Constructed of steel throughout, they have the usual watertight compartments with a double collision bulkhead fitted forward. They each accommodate 320 first-class, 225 second-class, and 280 third-class passengers. There is no need to describe in detail the

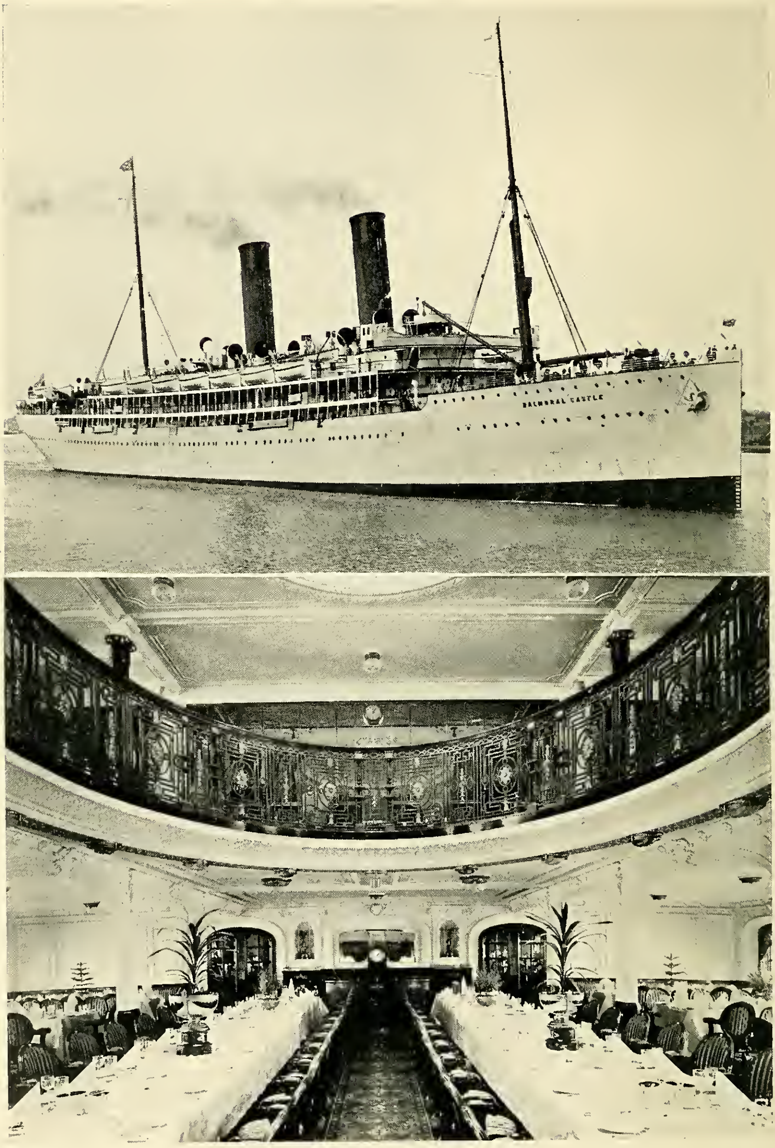


PLATE LVII.

UNION-CASTLE LINE S.S. "BALMORAL CASTLE."

FIRST-CLASS DINING SALOON.

various apartments occupied by the passengers in the passage to the Cape.

The kitchen arrangements are complete with every convenience to be found in the largest hotel. In the first and second-class pantries are patent egg-boilers, which automatically lift the eggs out of the water at any time desired by the cook. In the baker's shop is a dough-mixer driven by electric motor, and the ovens can be heated to 500 degrees by sealed hot-water pipes. The cold storage rooms are commodious and usually contain about 60,000 lbs. of fresh meat, 6000 head of poultry and game, 10,000 lbs. of fresh and dried fish, and numerous other items required for table, such as butter, bacon, ham, cheese, fruit, vegetables, etc. The dining services require about 60,000 pieces of crockery, 6000 pieces of glass and 12,000 pieces of electro-plate and cutlery; a consideration of these figures gives one some slight idea of what is required in these directions on some of the great liners described in earlier chapters.

The foregoing vessels have recently been surpassed in size by the "Balmoral Castle" and the "Edinburgh Castle," 13,360 tons each. Even before the completion of the former she was selected to take the then Prince and Princess of Wales to South Africa to attend the opening of the new Union Parliament. The lamented death of King Edward and the accession of King George to the throne caused an alteration in the royal plans, the Duke and Duchess of Connaught carrying out the original programme.

For this special service the "Balmoral Castle" was commissioned as a King's ship and was manned and officered by naval men.

Other notable mail steamships of this line are the "Walmer Castle" (12,546 tons), "Saxon" (12,385 tons), "Briton" (10,248 tons), "Kildonan Castle" (9692 tons) and "Kinfauns Castle" (9664 tons).

Until quite recently it was a matter of reproach to us, that there was no direct British steamship service between the United Kingdom and the East Coast of Africa; and that the only unbroken means of communication was by the vessels of a German line. Passengers for East Africa by British vessels sailed *viâ* Capetown, and transhipped at Durban for Delagoa Bay, Beira, Chinde, Mozambique, Zanzibar, and Mombasa. This stigma—for it was no less from both a maritime and an Imperial standpoint—was removed in September, 1910, when the Union-Castle Mail s.s. "Guelph" left Southampton for the principal East African ports *viâ* the Suez Canal. The new link thus forged will be maintained by a service of intermediate steamers calling at Marseilles and Naples.

Having arrived at that stage when there remain only a few pages of our allotted space, one

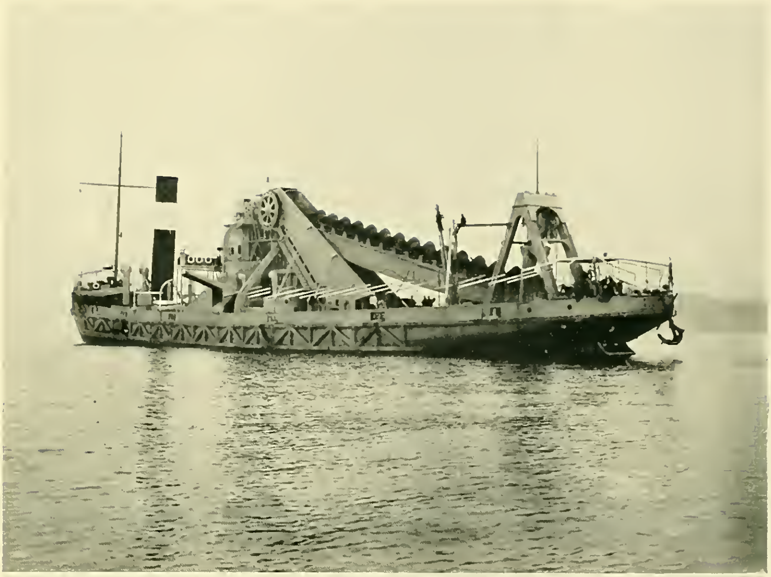


PLATE LVIII.

"PELUSE." LARGEST BUCKET-DREDGER AFLOAT.

TELEGRAPH CABLE STEAMSHIP "AMBER."

is at a loss to know with what to conclude out of the vast amount of information still remaining at our disposal. There are quite six score important British Shipping Companies, many of which have not been mentioned even indirectly. Many of their vessels are engaged only in the cargo trade, but they visit every port in the world where there is a market for our multitudinous manufactures, or where there is a product to be picked up to convey to our shores either for food, or as material to employ our manufacturing energies.

We might describe the pleasure steamers that ply down the Thames to various popular watering places, or similar vessels that cater for the enjoyment of excursionists at numerous seaside resorts, or the great ferry boats which, at intervals of every few minutes, cross the Mersey to and from Liverpool and Birkenhead. There are steam trawlers round our coasts, especially in the North Sea, sweeping up millions of tons of fish in the course of the year. Steam dredgers are constantly removing mud and silt from various water channels that would otherwise become too shallow for ships to traverse them. The largest bucket dredger in the world is the "Peluse" (Plate LVIII), which is employed in dredging the Suez Canal. Special steam vessels are also engaged in the laying and repairing of submarine telegraphic cables. Such a steamer is shown in the illustration, Plate

LVIII, in which can be seen the picking-up and paying-out gear at the ends of the vessel. We can touch upon none of these in detail, but will satisfy ourselves with a rapid survey of the railway steamships that connect England and Scotland with Ireland, or that give us constant and rapid communication with the Continent.

All of the chief railway companies of England and Scotland are shipowners, except perhaps the Great Northern, and that is, at least, interested in the vessels of some of the other companies.

As early as 1848 the Chester and Holyhead Railway owned steamers for service to Ireland, which only a few years later became the property of the London and North-Western Railway Company, which now owns about a score of vessels, of which the largest are the "Anglia," "Scotia," "Cambria" and "Hibernia." They are each twin-screw passenger vessels, 338 feet long, about 1800 tons, and speed 22 knots. They sail daily from Holyhead to Kingstown, and nightly to Dublin; and, of course, they run in strict conjunction with the Company's London to Holyhead railway services.

The Midland Railway Company in 1904 opened Heysham, a new port, from which to despatch steamers to Belfast. Their vessels are the twin-screw, 20 knot steamers "Antrim" (2099 tons) and "Donegal" (1996 tons); and the turbine steamers "Londonderry" (2086 tons) and "Manxman"

(2173 tons). This last-named is a particularly speedy vessel capable of 23 knots an hour. Other services are between Heysham and the Isle of Man, and between Barrow, Heysham, and Belfast.

The Great Western Railway port for Ireland was formerly New Milford, from which vessels crossed to Waterford ; but the Irish service is now between Fishguard and Rosslare. Of the two dozen steamships and tenders owned by the Company, the four largest are the turbine steamers "St. George," "St. Andrew," "St. Patrick," and "St. David," all of 22¾ knots an hour, or accomplishing the 54 nautical miles, the shortest distance between England and Ireland, in 2¾ hours. The Company has services between Weymouth and the Channel Isles, and between Plymouth and Brest (France).

The Portpatrick and Wigtownshire Joint Railways have three steam boats crossing to Larne from Stranraer. The largest is the "Princess Maud," a turbine steamer of 570 tons and 20 knots an hour.

The Lancashire & Yorkshire Railway Company owns 36 steamers to serve its regular lines from Fleetwood to Belfast or Londonderry, between Liverpool and Drogheda, and between Goole and Hull and Continental ports.

The Caledonian, North British, and the Glasgow and South Western Railways have capital steamers plying between the Clyde and most of the West Highland lochs, but for which, many beautiful spots would be practically inaccessible to the ordinary tourist.

The railway steamship services to the Continent are of immense importance. The Great Central Railway has 16 steamships, ranging from 2000 tons down to 646 tons, with regular sailings between Grimsby, Hamburg, Antwerp, and Rotterdam.

The Great Eastern Railway Company's services from Harwich to the Hook of Holland, Rotterdam, and Antwerp employ over a dozen vessels of which the largest are the sister ships, "Munich" and "Copenhagen." The "Munich" is a turbine steamer, 331 feet long, tonnage 2410, indicated horse-power 8500, and speed 21 knots. The vessel is fitted with triple turbine engines of the Parsons' marine type, supplied with steam from five single-ended boilers, working at a pressure of 160 lbs. on the square inch. It has two promenade decks, one carrying the boats, the other the awning deck, forming a spacious and covered promenade. On the awning deck are a number of fine state-rooms. There is ample sleeping accommodation, and passengers who are bad sailors may retire to rest upon commencing the voyage, and awake to find themselves on the other side of the North Sea. All the steamers on the Hook of Holland route are fitted with wireless telegraphy.

The London and South Western Railway has a score of steamers, three of which, the "Alberta," "Frederica," and "Lydia," form the Royal mail service between Southampton and the Channel Islands. There are other services to Havre, Cherbourg, and St. Malo.

The South-Eastern and Chatham Railway Company was the first to introduce the turbine into a railway fleet. The Company has five turbine steamers, five paddle-wheel passenger steamers, and eight screw cargo vessels. The largest passenger steamer is the "Empress" (Plate LIX), 324 feet in length; 42 feet beam; 1600 tons; 9000 horse-power; and speed 22·5 knots. The services are between Dover and Calais, and between Folkestone and Boulogne. Another fine turbine vessel is the "Invicta" (Plate LIX), photographed while steaming at 22½ knots per hour.

The London, Brighton & South Coast Railway steamers trade chiefly between Newhaven and Dieppe by means of eighteen steamships, most of them jointly owned by the Company and the French State railways. The largest are the turbine steamships "Dieppe" (1215 tons) and "Brighton" (1129 tons).

The passage across the Channel, even in its narrowest portion, is often a veritable purgatory for passengers who are not good sailors; but the adoption of the turbine which has added to the speed, and at the same time reduced the vibration, has done much to rob the passage of its worst terrors. Some day, perhaps, the 21 miles between Dover and Calais will be tunnelled, and the iron horse will then add another victory to its long list of conquests.

PLATE LIX.

RAILWAY STEAMSHIPS.

S.S. "INVICTA" STEAMING 22½ KNOTS AN HOUR. DECKS OF S.S. "EMPRESS."

CHAPTER XXII

STEAM IN THE NAVY

IN an earlier chapter we read of the beginnings of the British Navy, but a regular standing Navy was not established until the year 1488, when the "Great Harry," at a cost of £15,000, was built and manned solely for the service of the king. A quarter of a century later Henry VIII. refused to view naval ships as simply transports for the conveyance of land forces, and he floated the "Harry Grace à Dieu," a three-masted double-decked vessel of 1500 tons, carrying 62 guns, which were fired through port-holes, a system hitherto unknown. Three reigns later the Spanish Armada, a fleet of 132 ships aggregating 60,000 tons, sailed up the Channel to annihilate 191 English ships, many of them small, and altogether only totalling half the Spanish tonnage. Lord Howard of Effingham, with Drake, Hawkins, Raleigh, Grenville, and other heroes of many a daring exploit in the Spanish main, speedily put an end to the high hopes with which the Invincible Armada had left home. Only a few battered and riddled vessels sought a way of escape by voyaging round the north of Scotland, where storms and other misadventures put the final seal upon the great defeat.

From that time forward the British navy became a reality, and when James I. came to the throne he succeeded to a fleet of over forty ships, nearly a score of which were at least each 600 tons burden. Under Admiral Blake the British flag waved triumphantly in many a naval encounter with the Spaniards, the Dutch, and the French. Vessels increased in size and improved in equipment until the battle of Trafalgar, where Nelson's famous victory secured for us the mistress-ship of the sea.

In the United States in 1815 "Fulton the First," the earliest steam war vessel, was ready for her trial trip, and in appearance at least she was a very formidable craft. She had a double hull, 156 feet long, 56 feet wide and 20 feet deep, and measured 2475 tons. The hulls were separated by a space of 15 feet; in one of them the boiler was placed and the engine was in the other; and a paddle-wheel worked in the space between the hulls. The vessel carried thirty 32-pounders, from which red-hot shot were to be fired; and the sides of the gun deck were nearly 5 feet thick, while the spar deck was protected by thick musket-proof bulwarks. Powerful pumps were carried, with the object of drenching the decks of an enemy and thus rendering the ammunition useless. Fully equipped, the "Fulton the First" made a trip of fifty-three miles in about ten hours.

The suggestion to adopt steam in the ships of the British Navy for a long time met with no support from the Admiralty; while the sailor-men generally laughed to scorn the idea of "tea kettles" in the Service. It was reckoned that paddle-wheels were too flimsy for warfare, while the very thought of a shot in the boiler-room filled the naval mind with horror. Even when steamships were at length recognized by the Admiralty, they were only employed for harbour purposes. This aloofness obtained until the Duke of Clarence, afterwards King William IV., became Lord High Admiral, and he put into commission the "Lightning," our first steam war vessel.

Within a year the Duke resigned, and steam was again relegated to the background until 1830, when five paddle-wheel war steamers each of 830 tons only were added to the list. They carried 32-pounder guns, could steam from eight to ten knots an hour, but also had sails so as to save their coal bills as much as possible. In due course various larger steam vessels were built, and one or more of them were attached to each squadron.

The naval seaman was scarcely reconciled to the innovation, when the marine engineers commenced to urge the advantages of the screw propeller. Paddle-wheels were viewed as folly in a war vessel, but to bore a hole in the stern, in which the screw could revolve in close proximity to the rudder, was viewed as nothing less than criminal weakness.

But the manner in which the screw gained favour in the mercantile marine, soon made an impression on my Lords of the Admiralty, and consequently in 1841 they ordered the construction of the "Rattler," a screw steamer of 850 tons. To settle the vexed question of paddle or screw a test was arranged. The screw-propelled "Rattler" and the paddle-steamer "Alecto" were tied together, stern to stern, and each then set full steam ahead. The supporters of the paddle-wheel had the mortification of seeing their favourite towed against her will, although she paddled desperately to defeat her opponent's intention. The result of this tug of war resulted in the adoption of the screw, but only for smaller vessels; and it was not until about 1850 that the big two-and three-deckers were converted into steamships. Conversion in many cases was not at all a difficult matter, for any big sailing ship usually carried a considerable amount of iron ballast, which weight was now replaced by boilers and machinery.

The progress which steam has made in the Navy can be well realized by noticing our ships which were engaged in the Baltic Sea during the Crimean War. Eleven sail of the line carried over 900 guns; eight screw steamers carried about 260 guns; and the same number of paddle steamers mounted only 143. The guns carried show that the biggest vessels were sailing ships.

The great improvements in ordnance and the destructiveness of modern shell fire played havoc with the vaunted "wooden walls" of the English, French, and Russians, and particularly did the vessels of the allies suffer when they were bombarding Russian forts. This led the Emperor of the French to give instructions for four small screw steamers to be plated with iron 4½ inches thick. They were completed in time to take part in the operations against Fort Kimburn that guarded the approach to the River Dnieper. Armed with eighteen 50-pounders, these small "ironclads" speedily showed that they were likely to meet the needs for which modern conditions called; they were able to approach much closer to the fort than the ordinary vessels; and while they delivered a terribly effective fire, the enemy's shot and shell did them little or no damage in return.

After the conclusion of the Crimean War, the French seriously set themselves to the construction of an armoured ocean-going vessel. They cut down their screw two-decker, the "Napoleon," and from the waterline upwards gave her a covering of iron five inches in thickness. This vessel was renamed the "La Gloire," and may be considered as the first real ironclad. The British Admiralty dared not stand still, and at the Thames Ironworks was constructed the "Warrior," of a type altogether new to naval shipbuilding.

Iron vessels had already proved their utility in the mercantile marine, but thin iron plates were no protection against cast-iron round shot, which not only penetrated the plates, but caused the flying pieces to aid the shot in completing its destructive work. But trials showed that 4½ in. iron plates would keep out a shot of 68 lbs., which was then the heaviest projectile; and the better to secure the plates as well as to deaden the concussion, there was also a thick backing of timber between the armour and the real iron hull of the vessel. The "Warrior" showed a great advance in another direction, for, although sails were not abandoned, her machinery was powerful enough to give her a speed of 14 knots. The ordinary wooden battleship was only 240 feet long, whereas this new ironclad was 380 feet, and as her armour and wooden backing alone weighed 1350 tons, her total measurement of 8900 tons far exceeded that of even the largest wooden screw three-decker. This new type of fighting ship created almost breathless interest in naval circles all over the world, and was something for other nations to copy, and quite naturally to improve upon.

But the best efforts of the naval shipbuilder were soon found to be no match for the gunmaker, who treated their plates of wrought iron as though they were cardboard. The shipbuilder gradually increased the vessel's iron jacket to a thickness of 22 inches, and for a brief period the gun was beaten. Then the gunmaker hardened his projectiles, with the result that the 22-in. plate was little more protection than so much cheese.

The gunmaker, however, had given the shipbuilder a new "wrinkle"; if projectiles could be hardened so could the plates. Presently ships were sheathed with wrought-iron plates with a hard steel face fused on the front, and again the gunmaker had to acknowledge himself defeated. Not for long, though, for a new gun was produced that sent projectiles clean through the compound plates, until the plate makers forged new plates that were made still harder by means of an alloy of nickel.

As the armour increased in thickness and hardness, so the guns increased in size until the advent of the 110-ton gun, charged with 960 lbs. of powder that flung a steel shot weighing 1813 lbs. It was perceived that guns could not go on increasing in size, and after "hoop" guns had had an innings Armstrongs brought out a new "wire" gun, which reduced the weight, while furnishing greater penetrative power. It was proved that a 51-ton gun could send a huge projectile through the air at 2700 feet per second, or 1651 miles an hour.

The plate-makers replied with new armour made of heated steel suddenly chilled with cold water. The 12-in. wire guns, the tubes of which were bound round with 105 miles of wire, found that even the toughest missiles could not play havoc with the new covering, and to pierce it cost at least £1000. But even this did not spell finality in the matter of armour plate, for in due course appeared the Krupp plate, only 6 inches in thickness but so adamantine that projectiles striking it at a high velocity are shattered as though they were made of glass.

Meantime it was found that the increasingly large guns needed to be worked more than on the broadside only; and thus they were mounted upon revolving turrets by means of which projectiles could be hurled broadside, fore or aft. Sails were entirely abandoned, and duplicate machinery and twin-screws were provided to give a vessel a double chance of escaping a breakdown, which would leave her at the mercy of a foe.

The "Warrior" was completed in 1861, and a glance at the "Devastation," the "Thunderer," or the "Dreadnought" in 1875, showed how she had been left in the rear in the race for effective-

PLATE LX.

H.M.S. "SUPERB."

ness. These new turret vessels varied from 9000 to 11,000 tons, of which about a third was accounted for by the armour protection. They carried four 35-ton guns, from each of which a charge of 200 lbs. of powder shot a projectile weighing 800 lbs. Presently the "Inflexible" put these vessels in the shade, for she was plated with 24 inches of iron, and carried four 80-ton guns, throwing projectiles of 1700 lbs.

Our chief concern, however, being steam rather than armaments, we must leave the gunner and the armour-plater, and content ourselves with a brief description of the various types of war vessel of to-day.

In 1906 a new type of battleship made her appearance, and her dimensions alone show how little she resembled the vessel of the same name that was the pride of the fleet in the early seventies.

H.M.S. "Dreadnought" has a tonnage of 17,900; length, 490 feet; beam, 82 feet; draught, 26 feet; speed, 21 knots. Cost, in round figures, £2,000,000.

This huge vessel aimed at meeting the fullest requirements of a battleship. Perhaps the reader's thoughts fly to the immense size of some of the express passenger steamships; but it must be remembered that a fighting ship does not have to provide accommodation for a large number of passengers, and she carries no cargo, over and above her own stores. The "Dreadnought's" armament (ten 12-in. guns and 27 smaller ones) is sufficiently powerful to allow her to match herself against any other vessel afloat; her armour is calculated to withstand the most penetrative of projectiles; her speed enables her to manœuvre quickly against any ship of equal size; her coal bunkers are of a capacity to permit long passages without replenishment; and, finally, her ammunition storage or "endurance," as it is technically termed, is exceedingly liberal. What this last means must be calculated for oneself, knowing that the cartridge and projectile of a 12-in. naval gun weighs over 1000 lbs. In brief, a modern battleship is only a huge gun platform, from which to fling the heaviest and most destructive projectiles.

H.M.S. "Superb" (Plate LX) is a magnificent specimen of the "Dreadnought" class, one of three vessels each of 18,000 tons and 21 knots, added to the fleet in 1907. Within about a year followed four vessels ("Vanguard," "Collingwood," "St. Vincent," and "Neptune") each over 19,000 tons; but in 1910 were floated the "Hercules" and "Colossus," both having a tonnage exceeding 20,000.

In August, 1910, the "Orion," the first of eight still larger battleships, was launched at Portsmouth. She has a length of 584 feet; beam,

$88\frac{1}{2}$ feet; and a tonnage of 22,680. Her turbine engines develop 27,000 horse-power, and give a speed of 21 to 22 knots. On February 1st, 1911, her sister ship, the "Thunderer," took the water at the yard of the Thames Iron Works and Shipbuilding Company. The armament of this new type of battleship consists of ten 13·5-in. guns, arranged in five turrets along the middle line of the ship, so that all can fire on either broadside, two forward, two aft, and one amidships. Each of these enormous guns weighs about 80 tons, throwing a shell of 1250 lbs., capable of perforating 12 in. of Krupp steel armour with ease at a distance of 7 miles. There are also twenty-four 4-in. guns, and half a dozen quick-firers for use against torpedo craft. In the original "Dreadnought" (1906) the weight of metal fired from the heavy guns on the broadside was 6800 lbs., whereas in this larger improved type the weight of metal is 12,500 lbs. End on, the weight fired is about the same in both types of vessel, viz. 5000 lbs. of metal.

The armoured cruiser, of which the "Indomitable" class is an example, may be described as a fast battleship with a speed of 25 knots, that at once affords her most valuable scouting qualities. This is the speed of the fastest Atlantic liners, and at this point it may be stated that the two Cunarders, of which we have read so much, were partly built by Admiralty subvention, and in time of need are at the disposal of the Government.

In time of war the two ocean greyhounds would render us inestimable service in bringing to the Motherland huge cargoes of wheat and other foodstuffs from the New World. It at once strikes one that their speed would only save them from the attack of an enemy in their rear, but if they met the foe end-on, the supplies of food would fail to reach their destination. The liners, however, would be mounted with serviceable guns, and in addition would be accompanied by "Indomitables," able to keep up with their friends in speed, and with their powerful armaments able to protect them from harm. Cruisers are often termed the "eyes of the fleet"; they are the frigates for which Nelson was always appealing. Such vessels can overhaul a flying foe, and keep it in check until the slower battleship can bring its heavier guns to play upon the enemy.

The speed capabilities of our best-armed cruisers were exemplified in August, 1908, when the Prince of Wales was returning from the tercentenary fêtes on the Plains of Abraham. H.M.S. "Indomitable" (17,250 tons) crossed from Quebec to Cowes in five days. From land to land the cruiser occupied less than three days, steaming over 1700 miles in 67 hours. So much for speed, but what of her offensive qualities? A 12-in. gun hurls a shell of $7\frac{1}{2}$ cwts. every 50 seconds, and the "Indomitable" carries eight of these tremendous weapons, so arranged that they can all be trained at once upon the same target while she is going full speed, and the enemy yet five miles away. The range of these guns is really ten miles, so that if an "Indomitable" were as far down the Thames as Woolwich, London, in the neighbourhood of St. Paul's, or the Houses of Parliament, would not be safe from the huge bolts that might come hurtling through the air. In addition to the big guns, the "Indomitable," and the similar vessels the "Inflexible" and "Invincible," each carry sixteen 4-in. guns.

During the last few years the armoured cruisers also have increased steadily in size. The sister ships "Lion" and the "Princess Royal" have a displacement of 26,360 tons, developing 70,000 horse-power by turbine engines, affording a speed of 28 knots. The armament consists of eight 13·5-in. guns and twenty-four 4-in. guns. They are placed in four turrets all in the centre line; two of them are forward, the second turret firing over the first ahead; one is placed amidships, and the fourth is astern. From either broadside can be fired 10,000 lbs. of metal, 5000 lbs. ahead, and 2500 lbs. of metal astern.

Of battleships there are three classes, the smallest of the 3rd class being 11,800 tons, but there are half a dozen new vessels now building that will exceed the "Dreadnought" by from 5000 to 8000 tons. Armoured cruisers are of all sizes, down to the new "Blanche," "Blonde," and "Bellona" of 3500 tons, 18,000 horse-power and 25 knots; armed with ten 4-in. 31-pounder guns, and carrying 450 tons of coal and oil. There are numerous fighting vessels that are indifferently called gunboats, small but powerfully armed, and specially constructed for service in particular quarters of the globe. For example, vessels of this type can enter the mouths of comparatively shallow rivers, while a battleship or a cruiser might not be able to approach within a mile of the shore.

The torpedo, a self-propelling submarine shell, is at once one of the greatest marvels and the greatest terror of naval warfare. These terrible weapons are chiefly launched from specially low craft, not easily seen at a distance, and travelling at 19 to 25 knots an hour, so that even when they are detected, it may be too late to avoid the danger. This brought into existence the torpedo-boat destroyer, a small vessel with a speed ranging from 30 to 45 knots, and furnished with particularly destructive machine guns. Such a speed quite overshadows any of the mercantile record-breakers, but a destroyer is a fighting ship, pure and simple, whose only load is coal and ammunition with which to wage war upon torpedo-boats. H.M.S. "Pincher" (Plate LXI) is a capital example of its class. She was built by Messrs. William Denny and Brothers, Dumbarton, and is shown as she appeared when engaged in her trial run.

Submarine boats are practically without our province, since, although they are propelled by steam when on the surface, they are driven by electric engines when submerged. They are naval diving-ducks, torpedo-boats that are able to launch their dread bolts at such terribly close quarters as to make a miss almost an impossibility, whereas the ordinary torpedo-boat would consider itself fortunate to get within a thousand yards of its prospective victim.

If the motor-driven liner prove a success, it is certain that the motor-driven battleship will follow in due course. "When the revolution occurs," says the *Telegraph*, "then, indeed, the strangest ships on which the eye of man has ever been cast will be afloat. We shall then have battleships which will be without boilers, and without funnels, leaving the whole deck-space free for the guns and for an increased number of guns, and practically without stokers, as the engines will be fed almost automatically with the heavy petroleum refuse. Increased space will be available for the crew, and for ammunition and stores generally.

"The ship will lie low in the water, with one mast, and no top hamper or smoke pennant—to reveal her presence directly she comes on the horizon. She will be cheap to run, silent in movement, inconspicuous on the sky-line, and uglier than anything which has yet been set afloat. She will be an embodiment of power, a mere mobile marine fort, without a vestige of the beauty which made old sailors love their ships with an intensity which no landsman could appreciate."

Time alone can prove what the marine engineer will achieve. The British Navy, our first line of defence, is the pride of our race, and we look to it to watch with jealous care that "precious stone set in the silver sea." Our war-vessels of to-day are manned by men still "feared for their breed and famous for their birth," hardy seamen filled to the brim with the courage of their wooden-wall forbears, and swelling with justifiable pride in the glorious flag that has "braved a thousand years, the battle and the breeze."

PLATE LXI.

H.M.S. "PINCHER," TORPEDO DESTROYER, ON ITS TRIAL RUN.

CHAPTER XXIII

RAILWAYS AND STEAMSHIPS AID MISSIONARY PROGRESS

STEAM, whether on land or water, in only the course of a century, has worked wonders for the material betterment of the world; it has annihilated distance, has promoted friendship between peoples widely different in colour, thought and habit, has multiplied trade, and has added to the comforts of life generally in a thousand and one different ways.

The beneficent work of steam, however, has had a wider, though, in many respects, a less apparent range. "Go ye into all the world and preach the gospel to every creature," was a Divine injunction, that, at one time, was terribly hard to put into practice. It may be accepted as generally true, that into whatever part of the world the white man penetrates he takes the gospel with him, at least indirectly. But that is not sufficient to comply with the plainest duty of Christendom; the gospel must be taken to the heathen of set purpose; it must be the be-all and end-all of specially concentrated effort.

Even if there were labourers for the harvest, and there never have been sufficient, it was through long ages a difficult matter to reach the spots where labour was most desirable.

Let us survey the world only a hundred years ago, viewing it as the Master's vineyard, and take stock where labour in His service was scarce or entirely unknown. Europe, with the exception of Turkey, was at least professedly Christian, although there was ample work remaining for the missionary even so near home. Asia, except for a few persecuted churches in Asiatic Turkey, was wholly heathen or Mohammedan; and Islam ruled in all the Lands of the Bible. Myriads of people in India had recently come under British domination, thanks to that famous empire-builder, Robert Clive, and his successors; but the great message had not gone hand-in-hand with conquest by force of arms. China was closed except for a few scattered bands of Romanists; and Japan, for two hundred years, had refused permission to Christians, even, to enter its portals.

We turn to Africa, a mere coastline. The vast interior was a sealed book; and, indeed, practically all that the White man had done for the Dark Continent was to view it as a happy hunting-ground for slaves to transport to the plantations of the New World.

South America in many regions was nominally Christian, owing to its long occupation by the Spaniards and Portuguese; but even these vast areas were sunk in terrible superstition. North America was Christian only on its fringe, where the White man had settled; and the Red men of the interior were really no nearer the message than when Columbus first crossed the Atlantic. Oceania was little more than a name to Western peoples; Australia we viewed as only fit for a convict settlement; and the beautiful islands of the Pacific were the home of untold ignorance and cruelty.

A survey of the world to-day presents a very different aspect. By the agency of steam the world has been drawn closer together, and British steamships in the ordinary course of their voyages to and from Australia steam round the world in 74 days. Faster vessels could improve upon this by several days, if there were any special reason for attempting it; and in any case by utilizing railways at various points the complete journey round the world need only occupy about one-half of the time.

Europe is now a network of railways. It is possible, for example, to take a not early breakfast in London and reach Paris in time for tea in the afternoon; or almost exactly the time that is required for a journey by rail from London to Edinburgh.

Asia, to a very great extent, remains the unchanging East, for the Oriental mind moves slowly, and the advance of civilization meets with all of which ingrained superstition and degraded ignorance are capable. Caste was ever one great obstacle to progress in India, but even this is receiving many rude shocks. It is almost impossible to exaggerate the moral effect of about 3000 miles of Indian railways ; and caste, in particular, is weakened by railway travelling. Even the most holy Hindu cannot be provided with a separate compartment unless he is prepared to pay for the extra accommodation. Travellers of all creeds require refreshment, and the European cannot be expected to ride upon the foot-board while the pious Hindu satisfies his hunger ; and if thereby his food is polluted, he finds in due course that he is not an atom the worse for the experience, and the wall of caste is assisted to totter to its fall.

Famine and pestilence long played a part in the history of India. In 1770, in Bengal alone, two million people died of starvation ; the dead and the dying lay in the streets of the cities in hundreds ; and dogs, jackals, and vultures fed openly on the carcases. Famine has occurred many times since then ; but the provision of tanks, reservoirs, and stores of grain has done much to lessen such horrors ;

and it is by means of the iron-horse that supplies of food are quickly hurried to the stricken districts.

There are numerous missionary societies at work in India, and far more workers than could possibly be there but for steamships and railways. The country has undergone a great change during the course of a century, as well indicated by the words of one writer :

"We shall never forget the 1200 dark faces in Trinity Church, Palamcotta; nor the fifty Tamil Bible-women sitting on the floor with their Bibles open on their laps while we talk with them; nor the Mission College at Calcutta or Madras, with its couple of hundred keen, bright-eyed lads drinking in our words as surely no English boys ever did; nor the assemblage of patients, men, women, and children, on the verandah of the Amritsar Medical Mission, waiting their turn to see the doctor, and, meanwhile, listening to the gentle words or soft singing of the helpers; nor the mud-built prayer-room in the Santal village, and the little company pouring out their hearts in simple supplications; nor the Oriental-looking church at Peshawar, lifting up the cross amid the minarets of that most bigoted of Moslem cities; nor the thirty Christian lepers in their little chapel, squatting against the wall, a sad and piteous sight, yet with their mutilated faces brightening at the name of Jesus. We feel it a grand moment in our lives when we grasp the hand of the once famous Mohammedan divine and saint, now for thirty years a faithful champion of the truth ; or of the half-naked, aged fakir, now giving his latest years to telling others of the Saviour he has found; or when we are greeted by the sweet Christian family, sons and daughters of a father who once worshipped stocks and stones, and then became an honoured clergyman, and of a mother belonging to the fourth generation of native Christianity."

Those are the words of but one man who had visited the stations of the Church Missionary Society ; other organizations can tell the same glad story. And there is no gainsaying the fact, that but for the assistance of railways and steamships such wholesale signs of Christian progress would have been quite impossible. Missionaries brave all perils in forcing their way into outlandish corners of the earth, where railways do not exist ; but, in the first instance, it is steam that has conveyed them to the nearest possible point to the scenes of their labours.

We go to China, which was closed to all Western intruders as late as the commencement of the reign of Queen Victoria. We find American missions at work hand-in-hand with their British brethren, and there is scarcely a province without its bands of Christian missionaries, though all too few to carry the message to more than a fraction of the huge population. Nevertheless, China is awakening, and everywhere are to be found Chinese Christians.

Only thirty years ago Christianity was a prohibited religion in Japan, but the gospel is now being made known to the wonderful people, who have astonished the world by the way in which they have seized upon the material benefits of civilization. The Japanese Christian Church is growing; there are Christian members of the Japanese Legislature, Christian officers and soldiers and sailors in the Army and Navy, and Christian policemen are guarding the streets. And in both China and Japan steam can claim to have rendered great assistance in the evangelization of the two nations, who so long held themselves aloof from the message.

In the Southern Hemisphere are evidences of splendid results, especially in the Pacific islands. Only 90 years ago the Church Missionary Society commenced work in New Zealand among the Maori cannibals, and nearly a hundred Maori converts have been ordained to the ministry of the Church of England.

In South America a century has witnessed a great improvement; and North America, especially the United States, has now a teeming population, English-speaking and Christian. The Red men are no longer neglected, and everywhere over the prairies, through the forests, on the rivers and across the lakes can be found little companies of Red Indians singing the praises of their Redeemer.

The Dark Continent has admitted the light. In West Africa, once the home of slavery and cannibalism, are self-supporting native Christian churches, and up the Niger are negro congregations and negro evangelists working with White men and women in this great corner of the vineyard. The Congo presents a vast region for missionary effort, and scores of devoted men and women are at work in regions that were unexplored thirty years ago. In Uganda one rejoices to meet with thousands of black Christians with their own clergy and teachers. Here again the Uganda Railway has rendered inestimable service in opening up the country and giving the missionaries easy access to a region that was formerly difficult to reach. Upon the great rivers and lakes of Africa, too, missionary steamships have proved of inestimable value. The Cape to Cairo Railway may do for Africa what the transcontinental lines have done for North America; easy communication means progress and light in dark places.

On Plate LXII is shown the missionary steamer "John Williams IV." The London Missionary Society has missionaries working on six different groups of islands in the Pacific Ocean. The missionary ship takes them to and from their

PLATE LXII.

MISSIONARY S.S. "JOHN WILLIAMS."

stations; and carries food, clothing, building materials, Bibles and other books from one place to another. As there is no regular service of ships between these islands, the work could not be carried on without the missionary ship.

The Society's first vessel was the "Duff," which sailed from London in August, 1796, bound for Otaheite. She left the missionaries at their respective stations and returned to England safely. The second voyage was less successful, for the "Duff" was captured by French privateers, and the missionaries and crew escaped only after great hardships. The "Messenger of Peace" was built at Raratonga by John Williams (the Apostle of the South Seas) with native help only. He used cocoa-nut fibre for oakum, bark for ropes, native mats for sails, and wood for nails. In three years the little ship sailed nearly 4000 miles. In 1834 John Williams came to England, and his work and adventures among the heathen aroused such interest that £4000 was raised, with which to purchase the "Camden," a 200-ton brig, as a missionary ship proper. In 1839 John Williams went in her to the New Hebrides, and was murdered at Erromanga. In 1844 a new vessel, the "John Williams," entered the missionary service. She cost £6000, which was raised entirely by children. She was at work until 1864, when she was wrecked upon a coral reef.

The boys and girls again came to the rescue and raised £10,000, which was spent in building "John Williams II." Her career was very short, for during a storm, she, too, was carried on to a reef and became a total wreck. In 1865, the children collected sufficient money to build and fit out "John Williams III." On one side of the vessel was painted, "Peace on earth," and on the other side, "Goodwill to men." For twenty-six years this sailing vessel did noble service. It was then found that a steamship was necessary to do the increasing work; and £17,000 was collected by the children and the S.S. "John Williams IV." was presented as a centenary offering to the society in 1894. Before leaving England she was taken to the principal seaports, so that a great many children could see their ship.

The headquarters of "John Williams IV." are at Sydney, and she regularly visits New Guinea, Samoa, the Cook Islands, the Gilbert Islands and other places, steaming every year about 30,000 miles. Remember she is the "Children's Ship," and the annual cost of about £7000 has to be raised by means of the children's "New Year's Offering Cards." The "Children's Ships" have, for sixty years, played a most important part in the glorious triumphs of the gospel in the South Seas, and there is a great work awaiting them in the future. Other missionary societies have various steam craft at work in different parts of the world, *e.g.*, on the great lakes in Central Africa, etc.

Here must end a rather rapid and cursory review of Railways and Steamships. Altogether their first century—really the century is not yet completed—encourages us to hope that they will be used increasingly to complete the great Kingdom of Him, who "hath smote for us a pathway to the ends of all the earth."

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THE END

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